THE

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THE ELECTRIC MOTOR IN AERONAUTICS.

MORE nonsense has been written concerning the art of navigating the air than about anything else, perhaps, and for the simple reason that aeronautics have hitherto been studied by faddists, or half-crazy inventors, who have been ignorant of the most elementary principles of mechanics and hydrostatics. It is curious that any new departure is certain to attract and dazzle the ignorant before it succeeds in awakening even a tentative interest in the minds of those who possess competent knowledge. Thus it has ever been; and it remains a problem in ethics which we cannot attempt to elucidate. Aeronautics may now, however, be reasonably termed a science, for men like Mons. Trouvé, Hiram S. Maxim, Dr. Berson, Prof. Carl E. Myers, Prof. Hazen, and Prof. Langley, have, in the last few years, been attracted to the study of the problem of "negotiating the azure." We may with justice expect that something tangible will result from their experimental researches.

The difficulty which Icarus, of classic fame, found in supporting himself *in aero* has long ago been overcome. The immediate problem is to produce a dirigible machine capable of being steered in any given direction at will and independent of the conflict of the elements. The motor by means of which the future air-ship is to be propelled and guided will probably be the most costly part of the development of aerial navigation, and in spite of the capable men who are considering it, it will be more largely a matter of empirical than of theoretical determination. A minimum of 10 lbs. weight per horse-power, and at most 15 lbs., has been calculated as necessary for the work to be done efficiently, or, indeed, at all; and this is at present the chief *crux* which the inventors have to contend with. Some are working upon steam engines; others are wedded to the various forms of gas or explosive engines, which have been found to yield a satisfactory account of the heat energy imparted to them; but in France, which, in the earlier stages of aeronautics led the way, the use of electricity is favoured.

For mere tentative experiments—and such are, and will be, for many years all attempts to navigate the air—electricity offers the most promising prospects of immediate results. Although an apparatus operated by such power might not, for some time, be an independent flying machine, it might be so manipulated that it would plainly indicate the requirements that a motor which would operate the independent machine must meet. The complete electric motor includes the source of the electric current, whether battery or dynamo. Unlike all other motors, however, it is possible to separate the essential parts of the electric motor; and not only to separate them, but to move them, with relation

to each other, as much as may be desired, and at any reasonable speed. There would probably be little difficulty in arranging rails, trolleys, and wires so that the current for operating the electric motor placed in the aerial machine could be conveniently generated and used. Thus we might, at first, realise a sort of electric railway with an aerial machine attached to the cars, and moving (not pulled) in the direction determined by the line of rails. Such, at least, would be a step from which more independent flights might ultimately be made.

We have stated that the minimum weight per H.P. has been calculated to be about 10 lbs. It is therefore well to remember that Mons. G. Trouvé, of Paris, has succeeded in constructing a small motor which develops energy at the rate of 1 H.P. for each 7 lbs. of weight. This is authentic, and is distinctly encouraging to those who are interested in aerial navigation, whilst it is of interest to all electrical engineers. Neither the gas nor the steam motor has done better; and it would seem as though, in the present state of our knowledge, the electric motor would be the easiest of all to develop the required degree of lightness and power. Moreover, experimental work in this direction would neither be so expensive nor so arduous. We are not amongst those who indulge in a cheap sneer whenever the subject of navigating the air is brought forward. Other apparently more impossible schemes have been realised within the experience of the present generation of electrical engineers. We honestly think that attempts to provide steam or explosive motors will prove costly, if not futile, and that the most promising direction in which to look for the realisation of Tennyson's much-quoted prophesy will be towards the development of the electric motor.

The Electric Transference of Heat.

Some interesting experiments have recently been made, from which it is possible to deduce several important conclusions, and which may, very likely, lead to practical applications. Researches by Thomson, Remsen, Rowland, and others have already shown that the difference of potential between a conducting body and iron depends upon whether the latter is magnetic or non-magnetic. Assuming that this demonstration is warranted by facts (and there is every reason for doing so), Mons. L. Houllevigne has pushed these investigations still further, and his results have been communicated by him recently to the Paris Academy of Science. Mons. Houllevigne considers a circuit formed by iron and some other conductor, for example, copper, and supposes that the two iron-copper junctions are infinitely far apart. The E.M.F. of such a system is necessarily zero. If, however, a magnet be placed in the neighbourhood of one of these junctions its difference of potential undergoes modification owing to the influence of the magnetism, whilst at the other junction the value of the difference of potential remains constant. A current should, therefore, be set up; but, obviously, this is impossible, because there is no permanent absorption of energy. Hence it is necessary that the variation of the E.M.F. produced at one of the junctions, in consequence of the magnetisation, should be compensated in the rest of the circuit. This compensation must occur in the magnetic parts, and it is natural to assume that it is of the nature of a continuous variation of potential between the sections which are unequally magnetised. The conclusion which we have thus argued out has been tested experimentally by Mons. Houllevigne in the following way: an apparatus was devised, the essential part of which consisted of a strip of soft iron, 1 cm. broad, 0·6 mm. thick and 50 cm. long. This was bent into two parallel branches, along which the electric current was passed, whilst a magnet was employed to produce the difference of potential sought for. To detect the effect a thermo-electric pile, formed of four bismuth-copper elements arranged in horse-shoe shape, was used. This pile being connected up to a Thomson galvanometer, the sensitiveness of which was such that an E.M.F. of $\frac{1}{1000000}$th of a Daniell cell introduced into its circuit, produced upon the scale a deflection of seven divisions. In such an arrangement as we have just described, if a current is passed along the iron strip a considerable permanent deflection (about 50 divisions) is at once produced. This arises principally from the difference of the heating effects (due to the term $C R^2$) at the two poles of the thermo-electric pile. When the direction of the current along the iron strip is reversed, a small deflection (about one division) is registered, which is only instantaneous, and evidently arises from a very slight but unavoidable modification in the magnetic field in the neighbourhood of the galvanometer, produced by the reversal of the current. The galvanometer, however, presently exhibits a slow deviation, quite distinct from the preceding, and amounting in a few minutes to about 3 scale-divisions; after which the needle remains at rest in its new position. Mons. Houllevigne states his opinion that the slow deviation reveals precisely the effect that might be expected, and he explains it by the following: "There is always an evolution of heat as the current passes from non-magnetised to magnetised regions of the circuit; and, on the other hand, an absorption of heat takes place when the current passes from the magnetised to the unmagnetised parts of the circuit. Hence, he argues, there exists between two sections of the circuit unequally magnetised (and in consequence of the magnetisation) a difference of potential in favour of that section of the circuit which is less strongly magnetised."

The Preparation of Tungsten by Means of Electricity.

Tungsten is a metal which, but a short time ago, was only a scientific curiosity: it seems probable, however, that in a little while it will be extensively used in the manufacture of hard steel and steel alloys. Already its use has given good results. Hitherto it has been a matter of some difficulty to extract tungsten from the refractory ores which contain it; but when ordinary smelting operations fail, electrical methods invariably succeed. A process has been devised by Krieg, which consists essentially in preparing the chloride, transforming this into tungstic acid, and reducing the latter to metal, the first and last of these operations being performed electrically. The preparation of the chloride is effected by using electrodes composed of a mixture of scheelite or wolfram and carbon for the production of an electric arc in the presence of chlorine. The metallic chlorides are extracted in the form of sublimates. Tungstic acid is next prepared from the product by treatment with hydrochloric acid, by means of which tungstic chloride (and silicon chloride) is decomposed, and other metallic chlorides which may be present are dissolved. By means of electrisation the tungstic acid is now freed from silica; it is finally made into electrodes with carbon and reduced to metal in a closed electric furnace.

THE CHLORIDE STORAGE BATTERY.

The President (Mr. W. W. Gibbs) of the Electric Storage Battery Company has written the following letter to the New York *Electrical Review* :—

"The Consolidated Electric Storage Company, controlling the Brush patents, knowing that in the chloride accumulator manufactured by the Electric Storage Battery Company the defects heretofore developed in the various types of battery constructed on the principles covered by the Brush patents have been practically overcome, have finally found themselves in the position where they must either abandon the storage battery field, or claim that the chloride system of storage did in some way infringe the Brush patents.

"Not being able by a systematic circulation of such statements to deter purchasers of storage batteries from taking the chloride battery in preference to the inferior batteries made by the Consolidated Company and their licensees, they have finally instituted suit, the only object of which, we believe, is to frighten intending purchasers of batteries who are not familiar with the subject, by the idea that there may be some foundation for their claim of infringement, and thus delay as long as possible the time when the chloride battery will be the only battery that purchasers requiring a satisfactory system of storage will accept.

"Without intrenching upon the province of the Court, or venturing to forecast its judgment, we are advised by the best of counsel, and the most eminent scientific experts in this country, after a most thorough examination of the state of the art, that we do not infringe the Brush or any other patents in the slightest degree. Among these experts are Prof. Charles F. Chandler, of Columbia College, New York; Prof. George F. Barker, of the University of Pennsylvania, and others, copies of whose opinions we will be glad to furnish to any who may be interested in reading them. We quote briefly from a joint report of Profs. Chandler and Barker, as follows:—

"'New York, *December 6th*, 1893.

"'W. W. Gibbs, Esq., President Electric Storage Battery Company, Philadelphia, Pa. :—

"'Dear Sir,—In reply to your inquiries as to whether your chloride accumulator itself, or the process by which it is manufactured, or the way in which it is used, in any way infringes the Brush secondary battery patents, or any of them, we beg to make the following report :—

"'Having been engaged as experts in the litigation between the Brush Electric Company, the Julien Electric Company and the Electrical Accumulator Company, we are quite familiar with the Brush patents and with the interpretation which has been put upon them by the judges of the United States Circuit Court and the Circuit Court of Appeals. . . . .

"'You construct a composite plate, consisting of tablets of chloride of lead and chloride of zinc, in a frame of metal. There is no active material in this composite plate, nor is there any material ready to become active in a secondary battery. Nor is there any material which is absorptive in a secondary battery.

"'In fact, as far as any use of this composite plate in a secondary battery is concerned, it is practically inoperative and worthless. Before any use can be made of this composite plate it must be exposed to a process of electrical disintegration, not in the bath or fluid of a secondary battery, but in a totally different bath in connection with plates of zinc. And only after this electrical disintegration is the plate of any use in a secondary battery. . . . .

"'Our understanding of the Brush claims is confirmed by the language of Judge Shipman, which reads as follows :—

"'The mechanical application of a layer of lead oxide to each of two lead plates, before the plates are placed in the battery fluid, these coatings being at once active material and ready for the charging current, when immersed in the battery fluid, was, in general terms, the distinguishing feature of the Brush invention. . . . These claims describe and necessarily refer to a secondary battery as heretofore defined; a plate or support which is insoluble in the liquid, mechanically supports the active material and electrically conducts the current of electricity through it; the specified active or absorptive material being oxides of lead, which are primarily mechanically applied to the plates, and in such state of minute division as to be at once capable of being charged without previous process of "formation" by electrical disintegration.'

"'In conclusion, we are, therefore, of the opinion that your battery does not, either in itself, in the process by which it is manufactured, or in its use, infringe the claims of the Brush patents.

"'We are familiar with all the batteries that have been held to infringe the Brush patents, and in all of them the distinguishing features of the Brush invention, as set forth in the above-quoted passages of the opinion of the Court of Appeals, were clearly present.

"'No battery such as yours has been held to be an infringement of the Brush patent, and from our understanding of the opinion of the court of last resort, the Circuit Court of Appeals, such conclusion would seem to be impossible.

"'(Signed) "'C. F. Chandler, Ph.D.
"'G. F. Barker, M.D.'

"A careful reading of these complete reports, we believe, will promptly convince anyone informed on the subject that there is no ground for any claim of infringement, and that the only hope and expectation of the Consolidated Company is to temporarily injure the business of the Electric Storage Battery Company, which they have been endeavouring to do for many months past by the circulation of false letters and statements.

"We, therefore, propose to continue making and selling our battery, and shall protect and save harmless all users of the chloride accumulator."

FRENCH COMMENT ON THE HEILMANN ELECTRICAL LOCOMOTIVE.

Our contemporary, *l'Electricien*, of the 3rd inst., affords a little insight into French opinion of the Heilmann engine, and considers that, after the Havre experiments have been sounded in every little hamlet by the daily papers and illustrated journals, some few words may now be allowed the electrical press, and proceeds to recapitulate the views expressed by *l'Electricien* in February of last year, relative to the greater safety that would be secured by the adoption of some means of avoiding the secondary movements consequent upon the piston movements, such as nosing, galloping, and pitching, as the various sinuous and rocking motions are technically termed.

This can only be attained by motors having perfectly balanced parts as electric armatures. Our contemporary gives a diagram of the general design of the dynamo, exciter, and motor, with the various switches, but does not vouch for the accuracy of this, as the Société Heilmann, or its representative, placed obstacles in the way of our contemporary, of which it is unable to fathom the exact reason. That by the way, however! This diagram shows, as already described, that when the main steam power is upon the dead point the armature of the dynamo can be switched into the outer circuit of the exciter and, becoming temporarily a motor, will move the engine off its dead points. It is remarked that there were four persons engaged in the running of the machine, to wit, the stoker and a young boy, who accompanied him to break up the coal briquettes, then two others forward, the driver and his assistant. As all these four are described as *personnes* with feminine adjectives, after the manner of this elegant tongue, one is almost at a loss to know what manner of men they were. When, further, our contemporory noticed even a fifth *personne*, who, from *his observatory* which *she* had chosen, gave orders to the driver, we can hardly consider the estimate of, at least, four employés being necessary to work this locomotive in service as far wrong. To one not thoroughly at home in the curious French genders, the description might easily convey the idea that the crew were simply so many feminines.

The weight of the engine and its train is given in tonnes, a French tonne of the old kind was 19·684 cwt., but we do not know if the ton of 1,000 kilos., or 19·646 cwt. is intended. The difference is not material. The locomotive weighs 113 tonnes, of which 13·6 are on each of the four axles of the leading bogey, and 14·7 on each of the trailing bogey axles. The train load, including two waggons, four carriages of three compartments, and a dynamometer car, with 100 passengers and 31 accumulator lighting cells weighed 70 tonnes. Thus of a total load of 183 tons, over

three-fifths was the engine, the weight of which, however, our contemporary thinks may easily be reduced.

The maximum speed attained on the outward journey was 74 km. per hour, the maximum electrical energy 480,000 watts, or barely 644 horse-power. Returning to Havre, a speed of 95 km. was attained (60 miles per hour) for a short time on a long descending gradient.

The maximum draw bar pull was 900 kilos, corresponding to 150 horse-power (French). Thus of a total of 644 horse-power (English) only 148 passed the draw bar; but, roughly, about two-fifths of 644, or about 246 horse-power should have reached the draw bar. In other words, 148 horse-power is, on the basis of the relative weights of engine and train, $\frac{70}{183}$ of the electric power, which should, therefore, have been only 387 in place of 644; this would make it appear that the efficiency of the motors was only 60 per cent., though it is not quite apparent that the connection of the draw bar pull of 900 k. is intended to refer to the period of output of 480,000 watts. We should think that it hardly can be, as there is scarcely likely to be 257 horse-power missing in the transformation.

L'Electricite puts all the figures as to the speeds and distances before its readers, and leaves them to draw their own conclusions as to the soundness of the system, and contents itself with giving M. Heilmann credit for having at least eliminated the ordinary perturbations of the locomotive: "The running is very sweet and oscillation almost entirely eliminated." Therefore, though M. Heilmann and they, themselves, do not possess similar opinions on the question of traction, they are pleased to recognise what has been effected by his syndicate, and it is only fair to give them credit for their work, which must, it is acknowledged, have been heavy.

"At any rate, though very much more serious proof will be required to persuade railroads to adopt such a system, a landmark denoting progress has been set up by these efforts."

DR. D'ARSONVAL'S EXPERIMENTS IN ELECTRO-PHYSIOLOGY.

The fresh paths opened up for electrical science by the production of oscillations of high frequency, says M. Guillaume in *La Nature*, have enabled both industry and electro-therapeutics to penetrate into regions hitherto unexplored. Dr. D'Arsonval, who was particularly well prepared for studies of this nature by a series of electrical inventions, pursued, in this direction, the splendid course of electro-physiological researches for which he has been awarded the La Caze prize by the Académie des Sciences. We will leave it to a more competent writer to treat of the purely physiological side of the question; but we think it will be interesting to describe certain extremely curious phenomena observed in currents of very high frequency, after briefly mentioning the apparatus from which they are obtained. Our readers are acquainted with M. Tesla's remarkable experiments; Dr. D'Arsonval's form their counterpart; the special object of the former was the production of light, the latter one their importance to the new facts that they reveal to us with regard to the relations between the nerves and electricity. Dr. D'Arsonval's apparatus are simpler than M. Tesla's, they are on a smaller scale, and produce less powerful effects, but they have the advantage of being within the reach of all laboratories, even those possessing the fewest well-known electrical instruments.

Dr. D'Arsonval's first researches were made some time ago, and the question of the physiological action of currents of *all frequencies* was solved in France long before M. Tesla's first publications in America.

Production and Properties of Oscillatory Currents.—We know that under certain conditions an electrical discharge becomes oscillatory. A very simple apparatus, the principle of which was borrowed by Dr. D'Arsonval from Dr. Lodge's experiments on lightning conductors, enables discharges of this nature to be produced, and an essential property of currents of high frequency to be shown. A Ruhmkorff coil, A (fig. 1), serves to charge through their inner armatures two Leyden jars, B, C, connected in cascade; the discharge which is produced between the opposite balls is oscillatory; the potential of the external armatures varies with the same frequency, but the current, in a wire which connects them, varies more suddenly than in the circuit containing the spark. If we connect the external armatures by a bobbin, D_1, D_2, consisting of 10 spirals of thick copper wire, they will be short-circuited for an ordinary current, and we should only keep up a difference of potential of a few volts between the armatures by sending into the wire a current sufficient to volatilise it instantaneously. But here the intermittent discharge shows its peculiar nature; it has an invincible repugnance to enter the wire. The reason of this is very simple; the extremely rapid variation of potential (thousands of volts in the hundred-thousandth of a second), which is set up at the terminals of the bobbin, produces currents varying with formidable rapidity, and consequently endowed with enormous inductive power. The induction of each spiral acts upon the adjacent ones, and the resulting current tends at each moment to annul the primary current, so that only a small fraction of the current passes. It is of no use, in this case, to calculate with resistance as defined by Ohm's law; we have to deal with quite a different antagonistic force, a combination of resistance and induction, to which the name of *impedance* has been given. This is the sum of the *impedimenta* opposing the course of the current. In the case we are considering, the impedance resolves itself practically into the antagonistic force of induction.

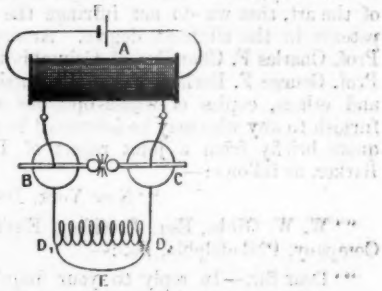


Fig. 1.—Principle of the Apparatus shown in Fig. 2.

We can, in the following manner, show how reluctant the oscillatory discharge is to enter the bobbin. On applying a wire, E, to its extremity, D_1, and bringing it near the last spiral, D_2, we shall see in the space between the wire and the bobbin a sheaf of sparks formed, more than a centimetre long (diagram and fig. 2, detail); thus the discharge will more easily traverse 1 centimetre of air, than a resistance which can practically be disregarded, but which possesses induction.

Physiological Actions.—What will happen if we touch the extremities of the bobbin? Apparently we shall receive the entire discharge, accompanied by so great a shock that, following the example of one of the greatest electricians, we would not repeat the experiment for the kingdom of France. To our great surprise, we feel not only no shock, but not even the slightest tingling. Has the discharge again changed its course? No, for if, instead of touching the bobbin at the two ends, we content ourselves with holding near to one of them a piece of metal held in the hand, we see the sparks reappear. What is more, we can introduce an incandescence lamp into our circuit, and we shall see it light up brilliantly (fig. 2). The current therefore passes through our body without our feeling it, thus showing another of its peculiarities. To what then is its harmlessness due? The first idea that occurs to us is that the current passes entirely over the surface of the body into the epidermis and the clothes. There is no doubt a certain amount of truth in this explanation, but this localisation of the current is not the only cause of its harmlessness. Dr. D'Arsonval's researches have shown that the neuro-muscular phenomena increase in intensity, with the frequency up to 3,000 alternations per second, remain to all intents stationary up to about 5,000 alternations, and then decrease, and soon cease altogether. A frog's leg is insensible to Hertz's alternator, as M. Joubert has shown. And yet the physiological

action of these currents is far from being *nil;* its passage into the tissues is accompanied by the following singular effects :—1. If for a certain time we close the current through the hands, which are provided with large metallic conductors, we find that the skin has become insensible.* This insensibility lasts from a few minutes to half an hour. 2. Under these conditions, if we insulate ourselves on a glass stool, taking one pole only, we experience a sensation of heat which is accompanied by copious perspiration and considerable vascularisation of the cutaneous surface. 3. Lastly, if we make a little wound in the foot of some animal so that the blood only escapes drop by drop, we find that the hemorrhage becomes very abundant under the influence of the current. There is therefore a powerful force at work tending to dilate the vessels.

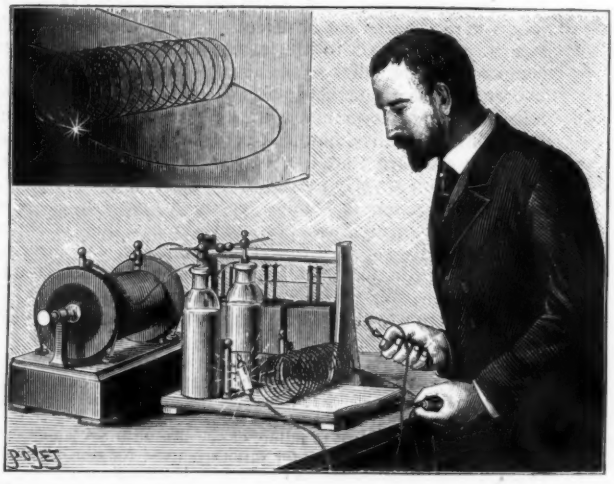


Fig. 2.—Apparatus for the Elementary Study of the Oscillatory Current and for the Demonstration of Impedance.

Fig. 4.—Auto-Conduction; A Lamp Lighted by Induction on a Single Wire.

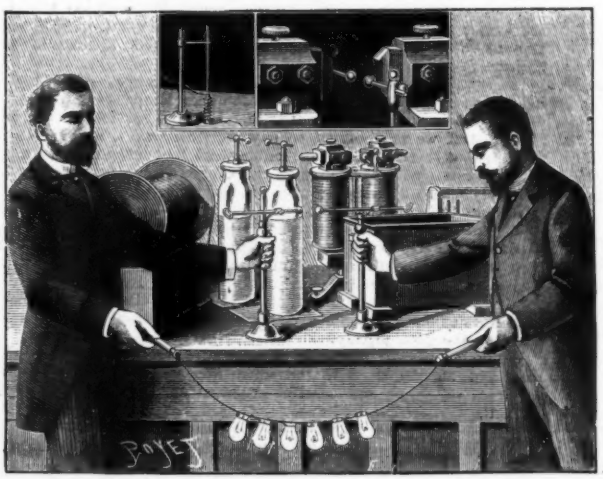


Fig. 3.—Apparatus for the Production of Intense Oscillatory Currents.—General View of the Apparatus; (2) Arrangement for Measuring the Current by means of the Thermometer; (3) View of the Sparks in a Magnetic Field.

Fig. 5.—Auto-Conduction; A Lamp Lighted by the Currents Induced in the Arms of the Operator.

The current therefore passes through the body, but the nerves have become insensible at this frequency. The experiments that we have just described may be made with the little apparatus which we have already described; but a more powerful installation enables the effects to be greatly increased without their being modified in any essential particular. Fig. 3 shows the larger apparatus; instead of the bobbin, we have a transformer supplied by an alternating current dynamo ;* the discharge spark of the Leyden jars, instead of being given off in the open air, is produced in a powerful magnetic field; it is thus expanded into a luminous circle, and produces a deafening noise. We light, as shown in the figure, not one single lamp but a whole series of lamps, which the operators hold in their hands without their being metallically connected with the apparatus. Referring to this experiment, M. Cornu said at the sitting of the Academy held on July 3rd, 1893, "There can be no doubt as to the enormous quantity of energy passing through our body; transmitted under the form of alternating currents with long periods (from 100 to 10,000 per second), it would have been sufficient to kill us; under the above conditions, it produced no appreciable sensation.

Auto-Conduction.—In all the experiments of which we have spoken, the oscillatory current, generated in a metallic

* See the *Bulletin de la Société Française de Physique* sitting of April 20th, 1892. In the same paper, Dr. D'Arsonval said :—"Alternating currents with a sinusoidal variation have several interesting effects on the system :—1. By expanding the sinusoid we can send into the body somewhat intense currents, causing neither pain, muscular contraction, nor chemical action. 2. By gradually increasing the frequency we succeed in provoking powerful muscular contractions which are far less painful, for an equal intensity, than if we use an induction coil." Dr. D'Arsonval also showed that death from alternating currents is due, in the first place, to asphyxia, and may be averted by artificial respiration, which is also worth trying in the case of persons struck by lightning. In the second place, the excessive heating produced by the contraction of the muscles brings about the coagulation of the blood.

* The dynamo gives, as a maximum, a current of 12 ampères at 350 volts, with 60 periods per second; the transformer brings the potential to 15,000 volts.

circuit, was utilised either for its physiological effects or for its physical action; but, as we have seen, the current possesses enormous inductive power. Why, then, should it not produce induction directly on the living tissues? Each particle of the body, or of the part under treatment, would thus become the seat of an electromotive force; and the whole body, or one part of it, would be uniformly penetrated by the currents which originate in the very heart of its

Fig. 6.—Lamp Lighted between the Hands of an Operator Placed in a Solenoid.

tissues. This is what Dr. D'Arsonval shows by means of the following experiments. We see in fig. 4 an operator with a lighted lamp on his forehead. This lamp, which is mounted on a single wire, is separated by a distance of a few centimetres from a crown with which it has no direct communication. This latter, which is traversed by the oscillatory discharge, develops in the ring the current required to feed the lamp. It is clear, therefore, that the head itself is traversed by similar currents.

The existence of the currents produced by auto-conduction in the human body may be rendered evident by a conclusive experiment. If the operator places his arms round a solenoid, as shown in fig. 5, forming a circle completed by a lamp, the terminals of which he holds in his hands, the lamp will be seen to light up. A similar phenomenon will be produced if the patient is enclosed in a solenoid (fig. 6).

The measurement of currents of very high frequency of course necessitates the employment of new methods. That which was suggested to Dr. D'Arsonval by chance during an experiment is not yet perfected, but it at any rate enables us to note the currents used, and reproduce them at will. The currents induced in the conductors give off heat, which is the measure of their energy. All we have to do, therefore, is to make the induction act on a mercury thermometer, and note the elevation of temperature, in order to get an idea of the intensity of the inductive current, if the frequency does not vary much.

We see at the top of fig. 3 (No. 2) the arrangement for the experiment; the thermometer is placed in the axis of a little solenoid, traversed by the oscillatory discharge. In a moment we see it rise 150 or 200°.

We have already obtained from currents of high frequency results that could not possibly have been foreseen four or five years ago. Some engineers think that they have an immense industrial future, and it would be very rash to contradict this opinion. Their physiological effects are very mysterious, and if we must give Dr. D'Arsonval the credit of having discovered some of them, we must not forget that in this branch of electrical science, which a few months ago had not been entered upon at all, nearly all remains to be done. The methods are created; we have now to begin work.

BATH TOWN COUNCIL AND THE ELECTRIC LIGHTING COMPANY.

We have referred two or three times to the arbitrary manner in which fines have been imposed on the Bath Electric Light Company. It is perfectly reasonable that an electric light company should be amenable to penalties on the occasion of failure or partial failure of public lighting, and no one wishes to minimise the grave inconvenience of such lapses; but a close investigation into the conditions prevailing at Bath shows that the Watch Committee of the Town Council have been unnecessarily severe on sundry occasions. We learn from a report of the head constable the startling fact that during the year 1893, *1,010 gas lamps*, and 214 electric lamps were reported out or defective. Yet the electric light company were fined to the extent of £30, while the gas company did not suffer in the least. This, then, is a serious matter, and clearly points to the fact that the Watch Committee entertain prejudices against the electric light. This unreasoning hostility, however, is to some extent accounted for when we learn that four of the members of the Watch Committee are directly interested in the local gas company.

Naturally Mr. Metzger, the general manager of the electric light company, has protested against this one-sided treatment. He appealed to the council for a fair hearing, but this appeal unfortunately was handed over to the tender mercies of the Watch Committee. It will be seen that Mr. Metzger's letter to the Town Clerk puts the matter forcibly but moderately:—

J. Stone, Esq. *January 29th*, 1894.

Dear Sir,—We beg respectfully to approach the Town Council with the view of laying before them a protest we have made repeatedly to the Lighting Committee against the existing system of fines imposed in the event of failure of our electric street lamps.

The lamps may fail to burn for various reasons for which we may, or may not, be responsible. If the lamp fails through negligence on our part, we cannot object to the fine. When, however, they fail from other reasons (such as gales, frosts, and the like, or by the kicking of the posts by the public), we consider we should not be held responsible. Even when lamps are extinguished by any of these causes, steps are immediately taken to get them alight again; and, in many cases, the light is only out for an hour. We are fined, however, the same; and last quarter £10 5s. was deducted from the total amount due to us. Our license clearly states that in the case of *force majeure* fines are not to be imposed.

We would also point out that directly the lamps are lighted an inspection of the entire area is made, and any lamps that are reported out are put in working order at once. For this service on the part of our staff we are obliged to pay overtime wages, and it will be obvious that there will be no inducement to continue this for the benefit of the public so long as the Council impose the same fine that they would if the lamp were out the whole night.

We are indebted to the Lighting Committee for half an hour's grace in which to put a lamp alight again, but this does not always give us time even to get to the lamp, after it is reported out. An hour would give us time to do this if reported without delay.

Gas lamps can often be seen out or burning badly, especially on windy or frosty nights, and although we believe that the same clause as to fines exists in both contracts, we never hear of fines being imposed on the gas company.

We do our best to make the lighting a success from every point of view and an attraction to the town, and trusting that the matter will receive a fair and careful consideration at the hands of the Council,

We are, yours respectfully,
City of Bath Electric Lighting Company,
(Signed) G. F. Metzger,
Engineer and Manager.

The Watch Committee some time ago informed the electric company that they would continue to fine them, and they have gone to the trouble of providing their inspector with a telescope with smoked glass lenses, to enable him to inspect the electric lamps.

There is one important point that should be brought to the notice of the members of the Watch Committee who are shareholders in the gas company. When they vote on matters concerning the electric light company they are acting illegally, and their votes are valueless. Apart from the legal aspect of the matter, however, the conduct of the Committee has been grossly unfair, and we are certain that the whole of the profession is with Mr. Metzger in his objection to the pernicious and wrongful system of fines. We think that few electric light companies have had such scurvy treatment meted out to them, but we have such confidence in the common justice of mankind, that if the matter were fairly considered by the whole of the Town Council, the Watch Committee must necessarily be censured for their objectionable impositions.

A TECHNICAL UTOPIA, LIMITED.

"The wise and goodly ordinances of the Utopians, among whom, with very few laws, all things be so well and wealthily ordered that virtue is had in price and estimation, and yet, all things being there common, every man hath abundance of everything."—(Robynson translation of "More's Utopia.")

Some 400 years or more ago, Sir Thomas More applied the term "Utopia" to the imaginary island which he represents to have been discovered by a companion of Amerigo Vespucci, and as enjoying the utmost perfection in laws, politics, and the like, in contradistinction to the defects of those which then existed elsewhere. The name has now passed into all the languages of Europe to signify a state of ideal perfection, and it will be a source of astonishment to our readers when we state that quite recently we have stumbled across, within less than 100 miles of the great metropolis, a little community which is but slightly, if at all, removed from the happy condition of Sir Thomas More's islanders. It must not be confounded with another Utopia, discovered during the last two years by Messrs. Gilbert and Sullivan, where the ideal life of its inhabitants is completely upset by the king of that charming country, whose strong leanings towards the English form of Government resulted in his eldest daughter, the Princess Zara, who is on her way from Girton, where she had taken a high degree, bringing in her train representatives of the causes which made England powerful, to wit, a Lord Chamberlain, an officer of the Life Guards, a captain of the Royal Navy, a Q.C., a county councillor, and a company promoter, collectively the Flowers of Progress. With these it is expected that the regeneration of Utopia will be complete.

The representatives of England's greatness soon make a clean sweep of the old abuses of King Paramount's Court. On the suggestion of the company promoter, the State is run on limited liability principles, subsequently this idea is carried further and every individual in Utopia becomes a limited company with a liability restricted to the amount of his declared capital. The Utopian army and navy are remodelled, the laws are improved, the native stage is purged, the peerage is remodelled on an intellectual basis, literary merit meets with proper recognition, and, still more important, the people discard their barbaric dress and adopt the tasteful fashions of England.

The people of Utopia are induced to rise and demand the expulsion of the Flowers of Progress, they complain that, owing to the introduction of English customs, the jails are empty, war is impossible, doctors starve for want of patients, in short, Utopia is swamped by prosperity. Then Zara realises that they have forgotten a most essential element, that is, government by party. Introduce that great and glorious element, at once the bulwark and foundation of England's greatness, and all will be well, it will bring sickness in plenty, crowded jails, and interminable wars. The people depart satisfied, and for the rest we must refer our gentle readers, who, during the Easter recess, may for once exhibit a desire to revel in a Utopian existence of a few hour's duration, to proceed to the court where Messrs. Gilbert and Sullivan hold sway. We cannot help thinking, however, that had these famous collaborateurs known of the existence of *our* Utopia, they would not have failed to add a youth, say, a budding electrical engineer fresh from a training school, to the train of the Princess Zara, and we trust we shall not be accused of giving Mr. Swinburne a free advertisement when we say that it can readily be understood how, by the introduction of the "Hedgehog" into the country, the peripatetic electrician could not only have helped on the necessary reform, but could also have transformed the whole court up or down.

Our community still retains its ideal state of existence, for its inhabitants are the youthful sons of fathers, to whom the blessings of Utopia have been denied, and no modern reformers have yet ventured to intrude within its sacred precincts and alter the customs which have there obtained since its original discoverer formed his little kingdom, for just as King Paramount was more or less absolute monarch of Utopia, so is Sir Edmund Hay Currie, the supreme ruler of the Currie Residential Technical Schools, Folkestone.

Turning from romance to realism, we happened to come across the subject of our theme in this way: Adopting the expression, invented, we believe, although not included in their long list of patents, by Profs. Ayrton and Perry, "One of us," was honoured by the request from Sir Edmund Currie to act as examiner to the senior engineering students of the schools for the Xmas 1893 examination both by setting their papers and taking them through a practical laboratory and workshop course. The acceptance of this necessitated several visits to the technical Utopia, and the result has been a thorough and searching exploration of one of the most interesting, useful and unique establishments in the kingdom.

These schools were founded in 1889 by Sir Edmund Hay Currie with the object of establishing a place of education somewhat on the lines of the public schools, but where the course of instruction should include some of the various branches of scientific knowledge and practical engineering, as well as modern languages and classical literature. It was hoped that the strength of these schools might be found in a combination of the public school life and training, with a course of instruction more fitted to the times.

The great success which has followed this undertaking has shown that there was a real want which these schools could meet. The schools are divided into two sections, junior and senior.

The junior school has recently been enlarged, and its field of action extended so as to include every subject that is required by the various examining bodies for entrance into any of the learned professions, the army, or the universities. Especial importance is attached to mathematics, and the study of physics and chemistry is begun at an earlier age than is usual. Latin, French, and German also form part of the regular course.

The senior school is intended primarily for those boys who, having passed through the junior school, wish to prepare more particularly for a scientific profession or for work at one of the universities, as well as for those who intend to compete for Natural Science Scholarships at Oxford or Cambridge, or for admission into Woolwich or Sandhurst. Others who are preparing for special examinations, such as the Intermediate Examination in Science and the final B.Sc. Examination of London University can accomplish the whole of the necessary work at this school.

In the senior school there are five separate courses open to a pupil. Three are in the branches of engineering—electrical, civil, and mechanical—the fourth is a science course where the facilities offered for specialising, *e.g.*, in chemistry, are exceptionally great, and the fifth is classical. There is always a class preparing for matriculation at London University.

The three engineering sections work together in machine design and drawing, steam and the steam engine, practical geometry, applied mechanics, and workshop practice; but there is a practical demonstrator for each section always at work, and special lectures are delivered on two days a week by the visiting engineers who are the directors of each department.

Boys taking the fourth and fifth courses have classes in Latin and Greek or follow up their special subjects while the purely engineering work is going on.

Modern languages—French, German, and Spanish—are taught by competent men, and the whole senior school is divided into classes for these subjects independent of any other class division.

Considerable attention is paid to the training required for boys who look forward to a life-work abroad or in one of our own Colonies. In the engineering departments the boys are separated into lower and upper divisions, the former being preparatory to the latter. The entire engineering syllabus extends over a period of three years.

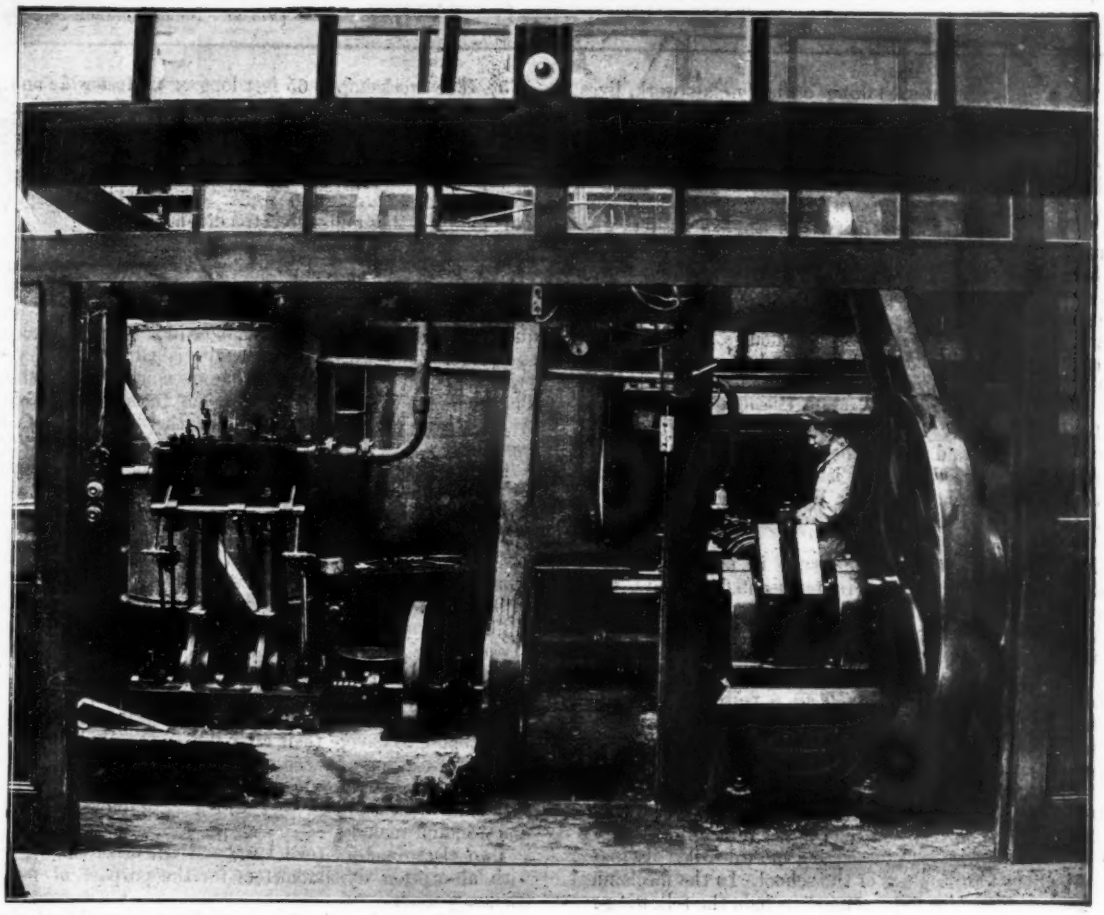
Only the fact that the staff is exceptionally large enables such a complicated division of classes to be carried out with success.

The greatest importance is attached to mathematics, such as any engineer must be well acquainted with, and thoroughness and accuracy are aimed at.

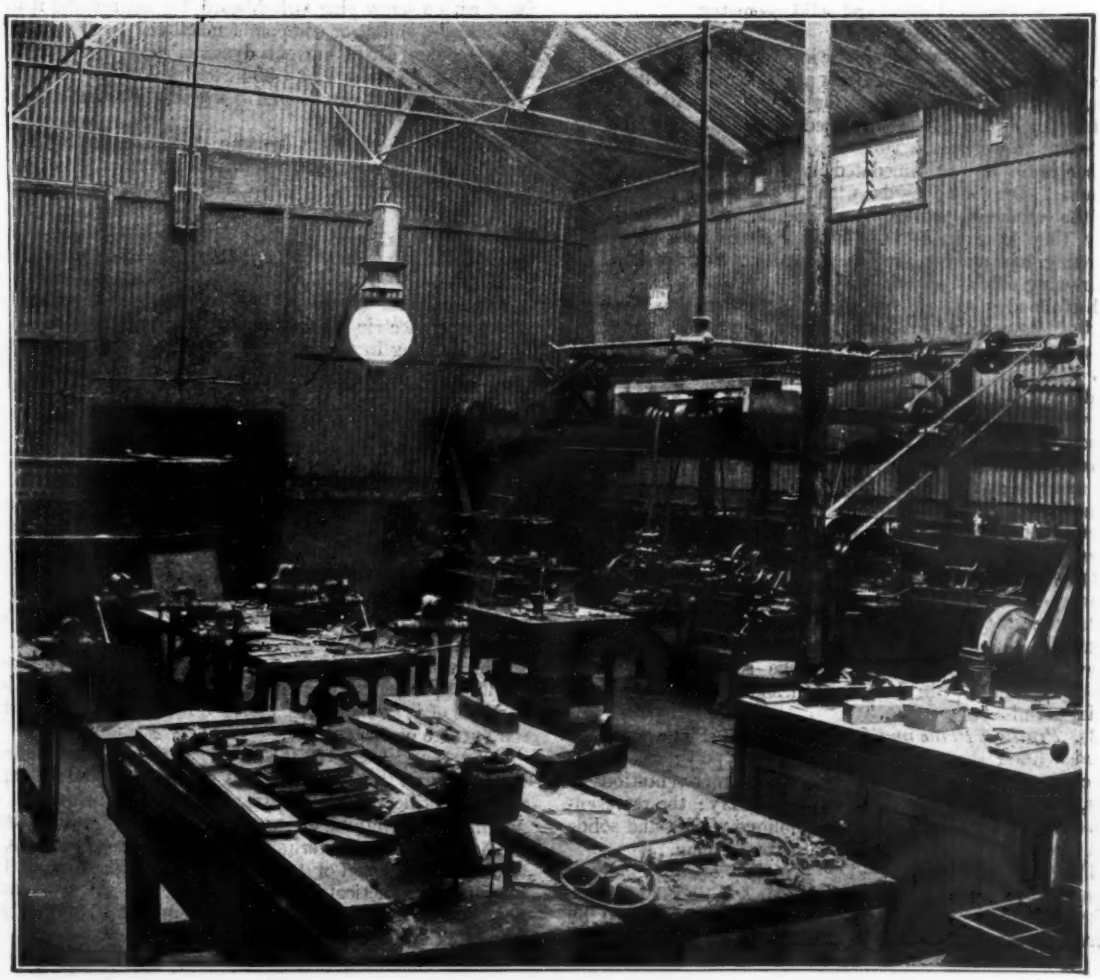
In the belief that it is hardly possible to teach modern languages thoroughly by class work alone, residential French and German houses have been opened, and found to be a success. Masters—the one a Frenchman, the other a German—who have passed their examinations at Paris and Leipzic, are engaged for this work. Each of these

Some of the Students' Residences.

Chemical Laboratory.



Engines.



Engineering Shop.

gentlemen in addition to taking ordinary class work, lives with a certain number of boys, and no English is spoken in his presence. Conversation classes are held each evening.

The ordinary work of these boys goes on as usual, but out of the regular hours they have all the advantages that could be gained by living abroad; with this important addition, that in the adjoining houses there are English masters who are responsible for the maintenance of proper discipline.

There are three sets of houses, arranged according to the ages of the boys: the younger ones live together in the same house with Sir Edmund and Lady Hay Currie, while the older and bigger boys are in separate houses. The heads of the houses are Cambridge or Oxford graduates who have been public school men. The houses are fitted with all modern conveniences, and everything is done to secure the health and comfort of the boys. Especial attention is paid to those who may be delicate; and so far, the climate of Folkestone and the surroundings of the school have in several cases proved wonderfully beneficial. During the evenings, boys work in their own studies, and assistance can always be obtained from the house master.

The number in the senior house is about 30. Most of the great public schools are represented by boys, some of whom have come for a course of two or three years' work in practical and theoretical engineering, some to prepare for university scholarships in mathematics or science, and some to obtain a special training in chemistry or physics.

Sir Edmund Hay Currie exercises a personal supervision himself over the whole school, and to him all matters are ultimately referred.

The school has its own church, which has been lighted throughout with incandescent lamps, by the boys themselves, as have also some of the houses and the various departments of the schools. To these we refer again further on.

We may now perhaps proceed to a more detailed discussion of the technical curriculum of the school. In the mechanical engineering department the courses include the following:—

1. Machine design and drawing.
2. Steam and the steam engine.
3. Practical plane and solid geometry.
4. Applied mechanics.
5. Workshop demonstration and practice.

The first four of these subjects are taken in the drawing office, which is a room 45 feet long by 30 wide, and has a height of 20 feet. It is furnished with desks at which 20 students can work at a time at drawing, and double that number could be accommodated at lectures on the various subjects. Drawing boards with T-squares are supplied, but the students provide instruments, set-squares, &c., which they keep in locked drawers fitted to the desks. Surveying instruments, engine indicators, &c., are kept in the drawing office.

The following will give an idea of the instruction given in the above-named subjects:—

(1). *Machine Design and Drawing.*—Students are taught to draw and trace neatly from copies, and, further, to design and draw out machinery, general arrangements and details, also to colour and finish such drawings. This course will include a general description of the materials used in the construction of machinery; the strength and properties of such material; their behaviour under loads; the strength and dimensions of bolts, nuts, rivets, keys, and cotters; the construction of pipes and cylinders; and the transmission of power by belts, ropes, toothed wheels and chain gearing.

(2). *Steam and the Steam Engine.*—In this subject lectures are given on modern steam engines and boilers, all the various types being fully dealt with. Special attention is paid to the setting out of valve gears and diagrams. Experimental work is done with the school engines and boilers, and engines in the neighbourhood are indicated by special permission.

(3). *Practical Plane and Solid Geometry.*—Plane geometry includes lines, the construction of scales, polygons, circles and curves, conic sections, and the graphic representations of areas, forces, velocities, &c. Solid geometry: the representation of points and lines in space, oblique planes, and solids in any position with sections taken through them.

(4). *Applied Mechanics.*—The principle of work, levers, screws, power transmission, wheel gearing, pulleys and belts, brakes, governors, and the mechanical advantages gained by hydraulic power.

(5). The workshop is 65 feet long × 36 feet wide and 20 feet high. It is well fitted with machines for working in wood and metals. One part contains wood-working benches at which 16 boys can work at a time under the supervision of a qualified carpenter. The fitters' benches are placed in another part where are 10 vices. The machines consist of four power lathes and three treadle lathes; there is also a shaping machine, drilling machine, grindstone, &c. The forge is placed in a room off the workshop, and is blown by a fan driven from the countershaft. A foundry on a small scale is set apart in the workshop, brass and iron in small quantities being melted in crucibles in a furnace placed in the forge. The work of the pupils is all done under the supervision of the mechanical engineer and his assistants. The workshop is open every afternoon for students wishing to do extra practical work under the direction of the engineers.

The workshop-tools together with the dynamos for lighting are driven by a 16 H.P. Otto gas engine. There is also a small launch engine of about the same power, which is used with the gas engine or separately. This engine was built by the students and has two vertical cylinders. Steam is generated in a tubular boiler which is set in a boiler house adjoining the engine room.

The general electrical engineering course embraces electricity and magnetism, theoretically and experimentally taught, electro-metallurgy, telegraphy, telephony, electric lighting, and the electrical transmission of power.

Special attention is devoted to the requirements of those who propose to devote their after-life to the practice of electrical engineering; hence a large equipment of electrical apparatus has been provided. This apparatus is of precisely the same character as that which is employed in actual practice, and includes:—

Two electromotors (one large and the other small), fitted with absorption dynamometers for the purpose of making efficiency tests.

A 4-pole Gülcher direct current dynamo, capable of giving 50 ampères at 65 volts and 1,400 revolutions per minute, fitted with a screw plug switchboard for connecting it up as either series, shunt, or compound machine.

A Goolden direct current dynamo, capable of giving 92 ampères at 65 volts and 1,300 revolutions per minute, arranged such that it can be used as a series, shunt, or compound machine.

An alternating current dynamo, capable of giving 10 ampères at 650 volts and 850 revolutions per minute, and having a stationary armature.

A 3,000 watt transformer, having a transforming ratio of $^{650}/_{65}$.

An E.P.S. secondary battery, composed of 32 cells, of the 11 K type.

A photometer of one of the best types, besides a large quantity of electric lighting and testing instruments.

The shafting in the shops is so arranged that it can be driven direct by either engine or by the electromotor.

The buildings are lighted throughout with the electric light, there being an equivalent of 230 8-C.P. glow lamps. The workshops are lighted by two 10 ampère Brockie-Pell arc lamps, one of which is intended for direct and the other for alternating currents.

Current is supplied to two large houses, about a quarter of a mile away, which are at present installed with an equivalent of 48 8-C.P. glow lamps, but when finished this portion of the load will be about 120 lamps. The transmission is effected by means of highly insulated 19/14 cable laid in iron pipes. The line is fitted with 6 inspection boxes, placed at intervals along it.

The whole installation, including the laying of the underground mains, has been carried out by pupils, and large portions of it are at times pulled down and re-arranged for the purpose of instruction.

After each lecture two hours' practical work is assigned to every pupil in the section. This work consists of the experimental verification of electrical laws and principles, the making and designing of apparatus and machinery, the fitting up and equipping of various kinds of electrical circuits, the tracing and removal of faults, &c. In order to more fully carry on the practical instruction, a large electrical laboratory has recently been erected, and fitted with a 20 feet slate and brick table for testing purposes.

The teaching in the chemical department is carried on by lectures, by reading and abstracting portions of standard works under the direction of the lecturer, and by practical work in the laboratory.

Courses of lectures are delivered in inorganic, organic, physical, and purely theoretical chemistry. Great importance is attached to the inculcation of clear and sound ideas upon the fundamental principles of chemical theory. It is held that, without such notions logically founded on experimental facts, it is impossible for a student to advance far as a chemist, or in other scientific pursuits to make satisfactory use of an elementary knowledge of chemistry. The theoretical side of the subject, therefore, is more fully treated than is usual at public schools. The history of chemical thought is briefly sketched in the lectures, in order that by the historical method the logical sequence of ideas may be more rigidly insisted on; and the elementary facts of organic chemistry are taught, since their great scientific importance renders it inexpedient to omit them.

In the Senior Division the students are divided into four sets according to their attainments, each set completing a distinct course of work before its members are removed to a higher class.

The junior boys form three sets in which they are instructed in the elements of chemistry as an experimental science and prepared for the higher work of the senior division.

Practical work, which forms an important feature, is carried on in a commodious laboratory, fitted with every convenience required by the practical chemist, and lighted by electricity. The work done embraces, in addition to the ordinary course of *qualitative* analysis taught in all laboratories, a selected series of fundamental experiments and *quantitative* determinations, which form the basis of a great part of chemical theory. As examples of such work performed by the more advanced students may be mentioned the following:—The plotting of curves to record a series of experimental results. Determination of Gay-Lussac's coefficient of elasticity of air at constant pressure, of the specific gravity of gases and vapours, of the volumetric composition of gases and deduction of molecular weights, of chemical equivalents, of specific heats and atomic weights by the laws of Dulong and Petit, of the quantitative composition of the air, &c. The less advanced pupils study simpler practical problems, *e.g.*, the investigation of the nature of combustion, proof that one-fifth of the air takes part in it, demonstration of gaseous diffusion in opposition to gravity, truth of the law of definite proportions, study of replacement, formation of acid and neutral salts with polybasic acids, &c.

On the completion of the course of fundamental experiments and that on qualitative analysis, those students who wish to carry their studies further proceed to a course of quantitative analysis, including both gravimetric and volumetric work; and those to whom such experience may prove useful hereafter are instructed in analysis of minerals by the blow-pipe, and the quantitative estimation of ores and commercial products. The laboratory is fitted with convenient fluxing and muffler furnaces, and the art of assaying both by the dry and wet methods is practised by those who are interested in the subject. A course of practical organic chemistry may be followed by those senior students who wish to take up that interesting branch of the subject. Practical work on the recent development of physical chemistry is carried on by the more advanced pupils, who are tanght all the modern methods for molecular weight determination which depend on osmotic pressure, &c.

The objects sought are—to give the ordinary student such a sound scientific training in the elements of chemistry as shall be of real service to him, both as a means of education, and as an efficient help in the problems of a future scientific or technical career; and to supply the advanced student with every facility for the further prosecution of his studies in whatever special direction may be most advantageous to him, whether he intends to become a professional chemist or a chemical engineer, to apply the science to some special branch of the arts, or to study chemistry for its own sake, or with a view to eventually becoming himself a teacher of others.

The teaching of physics is likewise carried on by lectures, followed immediately by practical work in the physical laboratory, where the aim, even with beginners, is to make every boy carry out some quantitative experiment at each attendance, and thus not only to cause him to become skilful in accurate work, but to enable him to form a concrete idea of the various physical quantities he will constantly be using in after life, whatever scientific profession he may follow. The subjects taught are mechanics, sound, light and heat, electricity and magnetism. When specially desired, the higher mathematical theory of these subjects is taken, or a more extended course entered into on the borderland between electricity and chemistry.

The physical department is just now being re-organised and fitted with lecture bench and seats, working benches for about 30 boys, large demonstration tables, cupboards, sinks, &c.; gas and electricity will be laid on to the lecture and working benches.

The present apparatus is sufficient to allow quantitative determinations of the chief heat constants being made, coefficients of expansion, specific heats, latent heats, and general thermometric and calorimetric work, &c. The stock of apparatus for the other branches of the science is being made as complete and comprehensive as possible.

The idea is to enable each boy to make *quantitative* determinations of the chief physical constants and quantities, and to understand the chief facts in each branch of science; to acquire a practical acquaintance with physical operations, and to train him in accurate methods of working and thought, and, finally, to guide him to adapt the knowledge so gained to the special circumstances which he may encounter in after life, whatever scientific profession he may choose to follow.

At the same time the theory is developed by lectures and experiments in the endeavour to show that science is not merely a collection of isolated and independent facts, more or less interesting.

The following is a list of the staff:—*Governor*, Sir Edmund Hay Currie; *Chaplain*, Rev. Reginald Harvey, M.A., Oxon, Keble College; *House Masters*, Mr. Orde, Mr. Mackenzie, Mr. Sillar; *English and General*, R. H. P. Orde, B.A., Cantab., Trinity College; R. L. Sillar, M.A., Oxon., Worcester College; *Mathematics*, M. A. Mackenzie, B.A., Cantab, Wrangler, late Scholar of Selwyn College; *Classics*, H. L. Brackenbury, late Scholar of Corpus Christi College, Oxford; *Chemistry*, A. Wentworth Jones, M.A., Oxon., F.C.S., M.R.C.S., L.R.C.P., late Exhibitioner of Balliol College; *Physics*, H. Holden, M.Sc.Vict., late Fellow of Owens College, Manchester; *French*, Henri Viard, B. ès L. Paris; *German*, Paul Jaeger, of Berlin University; *Spanish*, H. P. Duncombe, Esq.; *Civil Engineering*, A. T. Walmisley, M.I.C.E., Fellow of King's Collge, London, Fellow of Surveyors' Institute; Mr. Hughes; *Electrical Engineering*, directed by W. Slingo; *Laboratory Assistant*, G. D. Parr, Assoc. M.I.E.E.; *Mechanical Engineering*, R. Hughes, M.I.M.E.; *Workshop Assistant*, James Malt; *Music*, Alfred Oake, L.R.A.M., A.C.O.; *Gymnastics*, Sergt.-Major Carter.

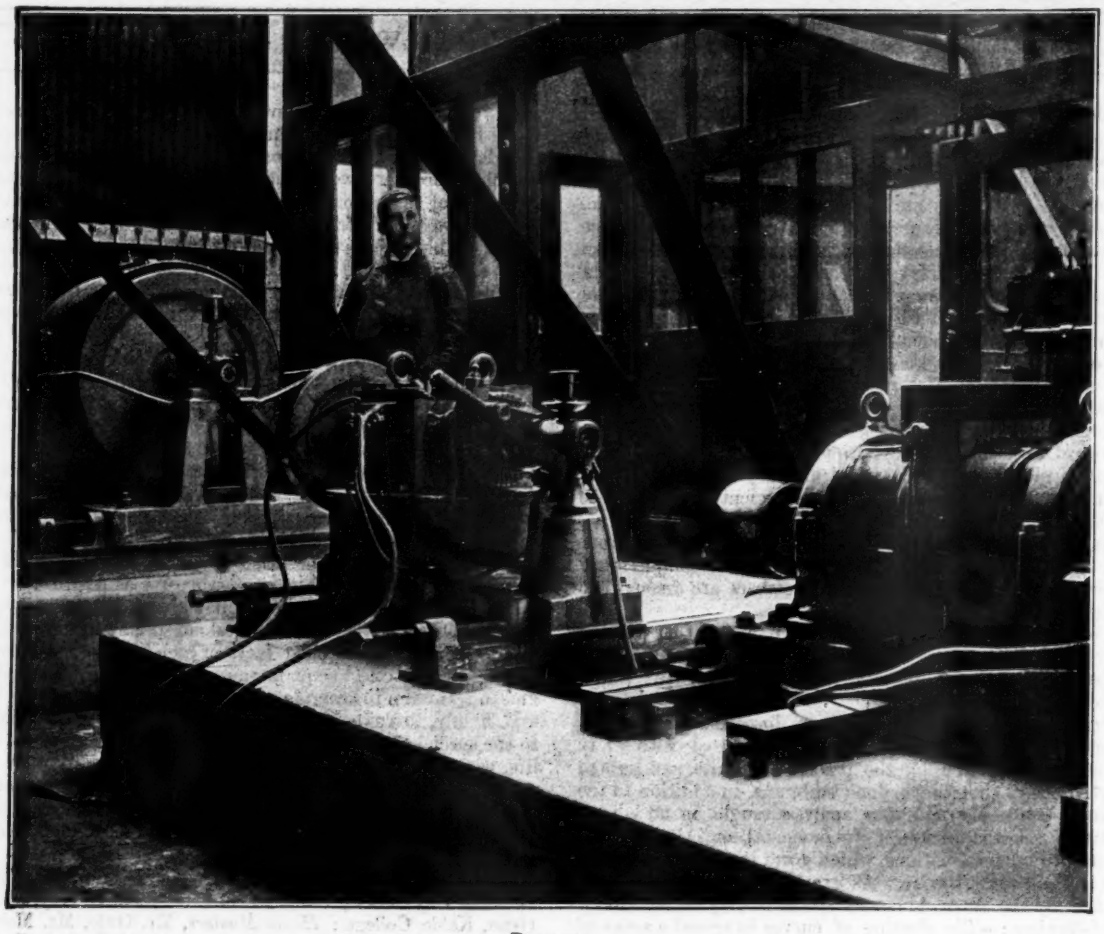
As a rule the boys share studies and bedrooms, though some have both to themselves. Every effort is made to give the senior boys as much accommodation and as much privacy as possible, and in no case are more than two of these boys assigned to one bedroom, or three to one study.

In football the Rugby game is played, and matches are arranged with the neighbouring schools and clubs, as well as with most of the London hospitals.

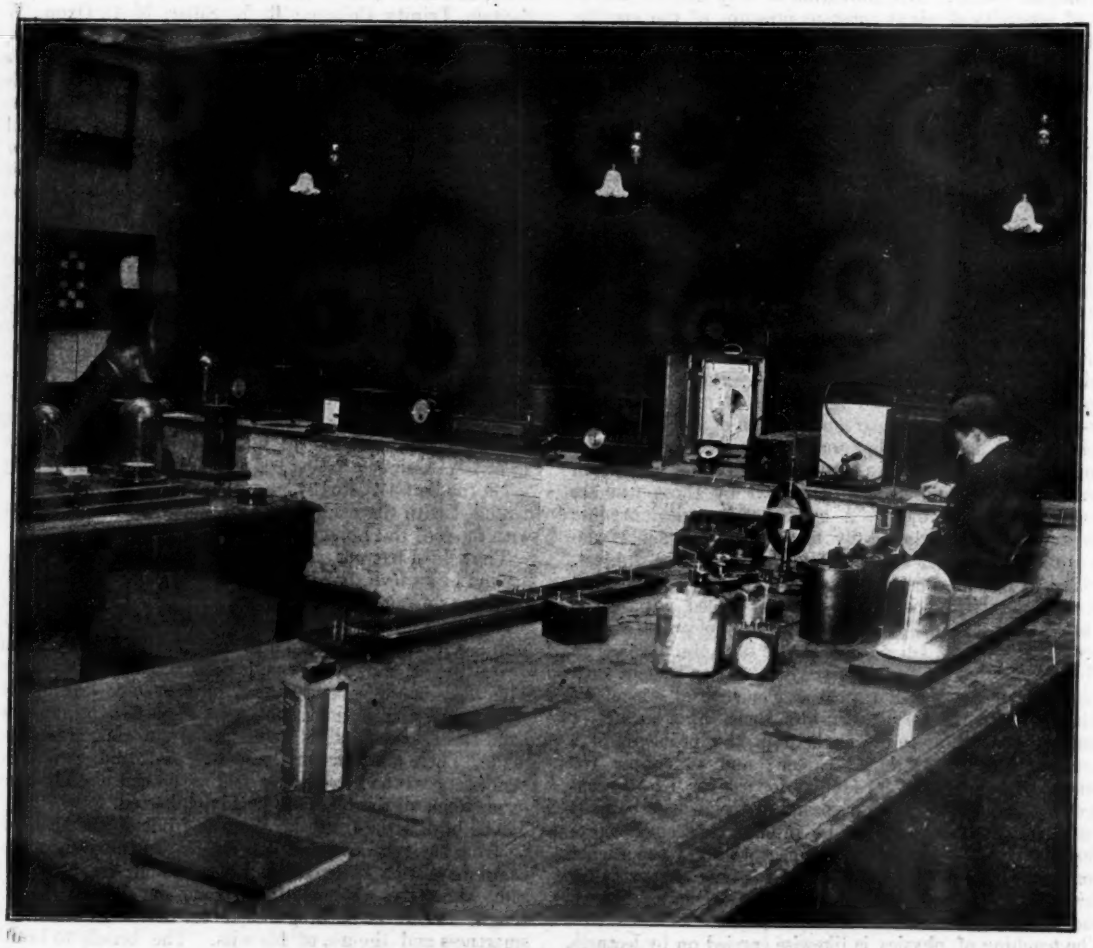
The school has not yet been able to get hold of a cricket ground of its own, but it is hoped that a private field will be available during the coming summer. Matches have hitherto been played on the Folkestone club ground, where the school club has its own nets for practice and its own professional.

Boating is, however, the feature of the summer term. The boat house is at the foot of the steps leading down from Castle Hill Avenue, not more than five minutes' walk from the schools, and is in charge of an experienced boatman. There are four-oars, pair-oars, gigs, and a great number of canoes, and a regatta is held at the end of each summer term, when all the races are keenly contested.

The boys bathe from the shore in front of the boat-house, or from their canoes, and it is a sight worth seeing when 30 or 40 boys with their canoes are in or on the water at the same time, the wind blowing strong on shore and the sea rough. There is nothing better calculated to teach a boy smartness and the use of his wits. The benefit to health is hard to over-estimate. Every precaution is taken to guard



Dynamos.



Electrical Laboratory.

against accident, and no boy is allowed in or on the sea until he has learned to swim. This he can do in the local bath.

There is also a sailing boat in which the boys can go out, there being competent hands on board to teach them something of sailing.

A small farm situated about a mile and a half from the school supplies milk and vegetables, and it is also proposed to experiment there with chemical manures, &c.

A social club called the Currie Engineering Club, of which Sir Edmund is president, has been formed to give the students greater facilities for the study of the science and practice of mechanical, civil, and electrical engineering. In the club room are to be found all engineering and scientific papers, together with a library of books and cases of interesting specimens. This room is fitted up with a view to comfort, and weekly meetings are held to discuss subjects suitable for engineering students. Excursions are made from time to time to manufacturing districts to see various places of interest and work being carried out.

The boys have formed a number of societies, among which we may mention, the Natural History, already very popular, the boys being keen collectors, and the Photographic, which has only just been started.

The Musical Society is, perhaps, the most successful of all, and bids fair to be still more so.

There is a very large and lofty gymnasium, in which the usual exercises are taught, such as boxing, fencing, singlestick, &c.

Having so far described a place where youthful existence can fairly be termed Utopian, we will finally express our own honest convictions of this admirable and specially conducted technical college, gathered, as we have previously mentioned, from actual observation and not from a casual walk over.

At Folkestone, both teachers and students appear to be thoroughly in earnest, and the Currie Schools give the impression that one is in a veritable hive of industry, in a real engineering works with school rooms and laboratories tacked on; other colleges we have gone through have struck us as being academic establishments with practical additions, which may or may not be turned to useful account.

In this age of craze for the technical education of the masses it is something to know where to send the classes, and we have satisfied ourselves that the schools over which Sir Edmund Hay Currie—himself so prominently associated with educational movements—so ably presides, are eminently fitted to give aspirants to engineering fame a thorough theoretical and practical training in all its branches, and this, combined with the social, recreative, and health giving advantages which are quite unique to the little community, render it admirably adapted for the complete technical training of the sons of gentlemen, and we know of no other college in the Kingdom which will bear comparison with the Currie Schools in these respects.

One touching little incident in connection with the schools is associated with the late fighting in Matabeleland, where one of the old boys was killed with poor Major Wilson when gallantly fighting against overwhelming odds. To commemorate this sad event the old boys of the school have subscribed for a handsome coloured window to be placed in the church as a memorial to their late comrade.

CORRESPONDENCE.

Balancing in a Three-Wire Station with only one Machine Running.

I must again beg permission to reply to Mr. Thursfield, and hope to clear the matter up this time.

It will be advantageous to make one or two notes before commencing.

In the first place the example dealt with is an extremely rare case. Everyone knows that it is very unusual to find in a three-wire supply station of this size, working at nearly full load, one quarter of the total current returning through the balancing wire. And secondly, I have always understood that the proper section for the balancing wire is one-half the sectional area of the feeder, and not one-third, as has been assumed; and there is no doubt that the former is the more economical proportion.

It has clearly been shown that the two sides of the armature can be loaded equally, or more advisedly, unequally, so as to give a volt or so more on the side where it is wanted. (By virtue of the very difference of potential drop between the two sides of the armature, which was first pointed out as an objection to this arrangement.)

Further, let us assume that the batteries have *no effect* on the voltage of the circuit, but only absorb or give out current according to the position of the discharging switches.

Taking, therefore, these points as established, we may proceed to consider a state of things which could only occur for a short time, during the hours of heaviest load, when some large groups of lamps are temporarily cut off all on one side of the balancing wire.

Then having, as before, 400 ampères on one feeder, and 300 on the other, and 100 ampères on the balancing wire, we can throw the station lamps, &c., on to the 300 ampère side; then arrange the discharging switches so that the battery ammeter needles show, say, 80 ampères discharging from the battery connected to the 400-ampères side, and 80 ampères charging the battery connected to the other one.

The side of armature connected to 400-ampère side of circuit is then giving $400 - 80 = 320$ ampères, and the remaining side of armature $300 + 30 + 80 = 410$ ampères.

The volts being at the brushes 111 and 109 respectively, then at the feeding points we have 105 and 110 volts, having duly allowed for potential drop.

This condition of affairs could not well last more than half an hour, and even if it did, who would be the wiser or worse? The customers who were getting 110 volts instead of 105 would not have a great deal to complain of, seeing that it is now fairly well established that it is economical to run lamps about 6 or 7 per cent. above normal voltage.

My thanks are due to Mr. Thursfield, but at the same time I do not see anything worth considering as a serious practical objection to using this arrangement for the particular purpose stated before.

Arthur H. Gibson.

March 17th, 1894.

Theryc-Oblasser Battery.

As my practical acquaintance with the Theryo-Oblasser battery is probably antecedent to that of anyone else in this country, I shall be extremely obliged if you will permit me to make a few statements in connection therewith, which may be of interest to many who have read your article upon the above accumulator in your issue of Friday, 9th inst.

Last year M. Theryc placed in my hands a small battery of two cells, and at the same time gave me some figures of results which he had obtained from cells of the same size and type.

I gave the battery a fair and impartial trial, and, without going into details over these particular cells, I found the claims made for the battery absolutely borne out by my experience.

With these very cells Dr. Fleming made his experiments, and while in my possession I had short-circuited them, not once or twice only, but time after time had allowed them to run down to 1·6 volts in that condition. I am speaking now of the small cell referred to in Dr. Fleming's report.

I have only this week experimented with one of our ordinary cells, the plates of which weigh just 6 kilos., the total area of opposed surface of positive plate being 192 square inches. The battery has been discharged at the rate of 7½ ampères per square foot of positive surface, with the following result:—

156 ampère hours at average voltage of	1·98
40 „ „ „ „	1·88
308·88 watt „ „ „	1·98
75·2 „ „ „ „	1·88
Total ampère hours obtained from battery	196
„ watt „ „ „	384·08
„ ampère hours per kilo of + plate	65·33
„ watt „ „ „	128
„ ampère hours per kilo of positive and negative ...	32·66
„ watt „ „ „ „ ...	64

There may, Sir, be cells capable of giving similar results, but I have never met them.

Any sceptic of eminence is perfectly welcome to make a test of this particular cell, or any other that we may have. I do not believe in the policy of comparison when advocating the claims of one's own articles through the medium of a public and popular journal.

Those interested, be they scientific or ordinary individuals, can compare for themselves, and as I have already stated, I shall be very glad to give anyone of reputation this opportunity.

Frederick E. Everard,
Manager,
The Universal Electric Lighting Company.

The Capacity of Leyden Jars Joined in Cascade or Series.

In S. P. Thompson's book of "Elementary Lessons in Electricity and Magnetism," p. 234, article 279, I find the following formulæ for calculating the capacity of Leyden jars joined in cascade. Let v = the potential between the inner coating of the first jar and the outer coating of the last; and let n = the number of jars, c the capacity of each jar, q the quantity.

Then, since v = the potential of n jars, therefore $\frac{1}{n}v$ = the potential of one jar.

Therefore, q for any jar will be $\frac{1}{n}\,c\,v$, and q for n jars will be $n\frac{1}{n}c\,v$; but $n\frac{1}{n}c\,v = c\,v$;

therefore, the charge of any number of jars joined in cascade = the charge that one jar alone would take for the same v.

Again, in the "Arithmetic of Magnetism and Electricity," by R. Gunn, on pp. 85-86. I find that if c = the capacity of any number of jars joined in cascade, and c_1, c_2, c_3, &c., the capacities of the different jars.

Then,
$$\frac{1}{c} = \frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3},$$

or
$$\frac{1}{c} = \frac{c_2\,c_3 + c_1\,c_3 + c_1\,c_2}{c_1\,c_2\,c_3},$$

$$\therefore\ c = \frac{c_1\,c_2\,c_3}{c_2\,c_3 + c_1\,c_3 + c_1\,c_2}.$$

Therefore, if the capacities of the jars are all equal, and $= c_1$, then
$$\frac{1}{c} = \frac{3}{c_1}, \text{ and } c = \frac{c_1}{3};$$

therefore, the joint capacity of three equal jars arranged in cascade is only equal to one-third the capacity of a single jar. If you, or any of your readers, would kindly inform me which is right, or how to blend them if it can be done, I would be much obliged.

J. Wilson.

[Both statements are correct, but our correspondent has apparently misunderstood the signification of the two. The statement made by Prof. Thompson in his book is that the quantity held by a number of jars joined in cascade is the same as that held by a single jar alone, if the combination and the single jar are in both cases charged to the same potential; this does not mean that the capacities are the same in the two cases, *i.e.*, that the quantity which would be discharged from the end plates of the cascade series would be the same as that discharged from the plates of the single jar. This is, perhaps, better explained as follows: Let there be three Leyden jars joined in cascade, and let v represent the potential of the outer coating of, say, the left hand jar of the series, and let v_1 be the potential of the inner coating. It is clear that v_1 will likewise be the potential of the outer coating of the middle or second jar, this being metallically connected with the inner coating of the first jar. Again, let v_2 denote the potential of the inner coating of the middle jar, and also of the outer coating of the third jar. Finally, suppose that the inner coating of the third jar is connected to earth, and is therefore at zero potential. Then if c_1, c_2, and c_3, denote the capacities of the first, second, and third jars, it is evident that $c_1\,(v_1 - v_2)$, $c_2\,(v_1 - v_2)$, and $c_3\,v_3$, will be the quantities of electricity separated at the various jars. Again, since the *minus* charge of the first jar must equal the *plus* charge of the second, we have $c_1\,(v - v_1) = c_2\,(v_1 - v_2)$. Also, since the *minus* charge of the second jar must equal the *plus* charge of the third, we have $c_2\,(v_1 - v_2) = c_3\,v_3$.

Hence, $\dfrac{v - v_1}{\frac{1}{c_1}} = \dfrac{v_1 - v_2}{\frac{1}{c_2}} = \dfrac{v_2}{\frac{1}{c_3}} = \dfrac{v}{\frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3}} = \dfrac{v}{\frac{1}{c}}$

suppose. Now $\dfrac{v}{\frac{1}{c}}$, or $v\,c$, will be the charge produced by difference of potential = v in a jar of capacity c. Again, it is evident that when the above series of jars is discharged, $c_1\,(v - v_1)$ will denote the quantity of positive electricity which circulates in the external circuit and, as just shown, this is equal to $v\,c$ when $\frac{1}{c} = \frac{1}{c_1} + \frac{1}{c_2} + \frac{1}{c_3}$. Hence the law that the joint capacity of jars in series is equal to the reciprocal of the sum of the reciprocals of the several capacities.—Eds. Elec. Rev.]

Electric Lighting of Steamships.

On reading the article on "Jerry Wiring" in your issue of the 23rd ult., it brought to my mind a case that occurred whilst travelling to West Africa on board one of the large steamers engaged in the West African trade, and which showed the dangers of scamped workmanship. The chief engineer had no knowledge whatever of the most elementary rules of electric lighting.

On the port side of the ship one branch of lights went out, and on asking the engineer if he had a plan of the ship's wiring, he replied that he never had any plan, and confessed ignorance of the meaning of fuse. The engine room had been in semi-darkness for several days; an examination showed that one of the switches, which was of the same form as shown in fig. 5 of your article, was half charred away and perfectly useless; also one of the leads, which was enclosed in a wooden covering, was very imperfectly insulated, the woodwork in the neighbourhood being quite charred and hot. After making a soldered joint, and getting a temporary switch put in circuit, the lights worked well, but the revelation had caused some uneasiness in the minds of the passengers. The ship was also fitted with electric bells, but being of the same gimcrack style of workmanship as the lighting, had never worked satisfactorily.

J. M. H., *Braz. Sub. Tel. Co., St. Vincent, C. Verde.*

The discussion on this subject, although voluminous, is little to the point, and somewhat premature; it is not men nor firms I am treating of in the articles, but *methods*. If I cared to follow Mr. Cline and Martin, I could give a list of names attached to faulty work done in the past; but I decline to be drawn into a personal squabble. If double wiring in wood casing is so excellent, and thousands of jointers are so highly skilled, and everything is so perfect in ship lighting with that system, and drawn-in wires in gas fittings are so satisfactory as Messrs. Tidd, Cline, and Martin try to make out, wherefore all this discussion? I am informed that nearly all the faults, fires, and failures have occurred with this double wired wood casing system, with its multiplicity of weak points and bad joints. The object of the discussion was wholly for the purpose of making some reasonable rules to ensure a better system, and enforcing the use of proper materials; the numerous complaints about failures in ship installations compelling attention.

The discussion might very well have been held over till the articles were finished, and the rules put in print for debate.

Examples of bad work, jerry wiring, and faulty fittings could be multiplied to any extent, and names of firms attached to them; but that sort of thing is altogether outside of the object of my papers. I leave that for others to follow.

Rankin Kennedy.

Mr. Kennedy, in the current issue of your journal, so frequently confuses "single" wiring with "concentric" wiring, that the error should not be allowed to pass uncor-

rected. "Single wiring" and "concentric wiring" are not synonymous. In single wiring, as the term implies, *one* conductor only is provided. The return conductors from the lamps being at the nearest points attached to the iron-work of the ship, through which the circuit is completed. In concentric wiring there are *two* conductors, the inner one being insulated, and having an outer conductor of at least equal conductivity laid over its insulation and concentric with it. Concentric wiring, as used on board ship, has no insulation over the outer conductor, but the important point is, that the outer conductor forms a continuous metallic envelope around the inner conductor, and therein lies the safety of concentric wiring.

No system of wiring has any claim to the advantages of concentric wiring which is not consistently concentric *throughout*. The switches and fuses should be in the inner conductor, and should be enclosed in brass boxes electrically and mechanically continuous with the outer conductor of the cables.

Concentric wiring has all the advantages named by Mr. Kennedy, and has others in addition. Let it not be confounded with "single" wiring, which is open to so many objections, and from a fire insurance point of view is essentially dangerous.

Sam Mayor.

[We have been compelled to hold over several letters from correspondents until next week.—Eds. Elec. Rev.]

AUSTRALIAN ELECTRICAL NEWS.

[FROM OUR OWN CORRESPONDENT.]

There is a diminutive central electric lighting station in Sydney which is, perhaps, deserving of notice. The enterprising proprietor of a ham and beef shop, who also manufactures sausages by means of a machine driven by a gas engine, being no doubt dissatisfied with the load factor of the plant, conceived the brilliant idea of utilising his gas engine to manufacture sausages during the day and electricity by night. The project having been carried into effect, it naturally followed that as the sausages were manufactured for export, the electricity was also used as a marketable commodity, and is now being sold to sundry neighbours for the purpose of illuminating their shops. Eight of the neighbours have seized the opportunity, and dispense their goods under the light shed from incandescent lamps; a ninth neighbour, a draper, being content with an arc lamp hung over the footpath to attract the passer-by to examine his wares. The total lights installed amount but to 2 arc lamps and 33 incandescent, but they are distributed amongst two drapers, a jeweller, fruiterer, tobacconist, grocer, dressmaker, confectioner, and wineshop. The charge is 9d. per week per 16-C.P. incandescent, and 10s. per week for an 8 ampère arc lamp. Central electric lighting stations in New South Wales do not run very large at present, as, for example, in addition to the above-mentioned one, the Moss Vale central station. This station, situated in a fashionable health resort, 2,200 feet up in the Southern mountains, commenced some three and a half years ago with a 100-volt 65-ampère Manchester machine, driven by a Robey vertical engine and semi-portable boiler, supplying about 30 street lights and a few private ones by means of bare overhead mains run on insulators. It has recently been extended by the addition of a 25-unit Kingdon alternator, driven by a 50 H.P. compound non-condensing Willans engine coupled, direct steam being supplied at 120 lbs. pressure from a locomotive type boiler made by Messrs. Woodhouse and Rawson. The capacity of the station is 500 16-candle-power incandescent lamps, but at present only about 140 have been taken up, including about 40 street lamps, the private supply being divided amongst about 20 consumers. One of the principal difficulties met with at present is due to occasional failure of the water supply, on which occasions the water has to be carted at a cost of about £2 per week, considerably more than the cost of coal—the coal used being about 2 tons per week, at 11s. per ton. The following scale of charges has been fixed by the company: For one 8-C.P. lamp, 35s. per annum, and a deduction of 1½ per cent. for each extra lamp, making the charge for 20 lamps £24 10s. per annum, which appears to be a very fair revenue per lamp; for anything over 20 lamps 30 per cent. is deducted from the net rate of 35s. per lamp. The rate for 16 C.P. lamps is 50 per cent. on the above prices. The following charge is made for fittings, as extracted from the company's schedule:—"Fittings—Plain fittings in houses situated within the range of the present wires of the company, as approved by the Underwriters' Association, which includes all necessary lamps, sockets, switches, fuses and wires, with required labour. For each light installed £1 5s., keys on lamps 1s. each extra. Fittings on a more elaborate scale as per arrangement." The present plant has been installed by Messrs. Woodhouse & Rawson.

The condition of affairs in Launceston are in a somewhat peculiar position just now. The following tenders were received:—

	£	s.	d.
Electric Construction Company	38,355	0	0
Siemens & Co.	32,021	15	10
Brush Electric Engineering Company ...	30,073	0	0
Henley's	28,615	11	11
I. R. & G. P. Company, cables only (1) ...	12,040	0	0
" " " " (2) ...	10,708	10	0
W. T. Glover & Co.	10,118	17	6

The consulting engineer, Mr. R. L. Murray, objects to Henley's tender, which was for Brush plant, and also objects to the Brush Company's tender as informal, as they suggest certain modifications in the extraordinarily rigid conditions of contract. The next lowest tender is Siemens & Co. The Australian agent for Siemens & Co. is a son of Mr. R. L. Murray. From the above position of affairs it will be seen that there is a possibility of trouble. There are rumours of a couple more fairly big electrical works coming off shortly in this and an adjacent colony, which should, in conjunction with the lapse of the incandescent lamp patents, give a bit of an impetus to electric lighting in this part of the world.

A meeting of electrical firms was called by the Brush Electrical Engineering Company, the holders of the incandescent lamp patents, a week or so ago to consider the future price of lamps, but owing to some mistake the meeting was, to put it mildly, but sparsely attended, and consequently nothing came of it.

NEW REGULATIONS FOR TRACTION.

The Board of Trade, after considering the suggestions, have modified considerably the tentative rules published in our issue of December 1st, 1892. The paragraphs which have been modified are marked with an asterisk, and we have indicated as far as possible the alterations by italics. Rule 17 under the old rules relating to the occurrence of sparking, has been entirely omitted.

Regulations.

* 1. Any dynamo used as a generator shall be of such pattern and construction as to be capable of producing a continuous current *without appreciable pulsation.*†

* 2. One of the two conductors used for transmitting energy from the generator to the motors shall be in every case insulated *from earth*, and is hereinafter referred to as the "line;" the other may be insulated throughout, or may be uninsulated in such parts and to such extent as is provided in the following regulations, and is hereinafter referred to as the "return."

* 3. Where any rails on which cars run, or any conductors laid between or *within* 3 *feet of such rails*, form any part of a return, such part may be uninsulated. All other returns, or parts of a return, shall be insulated, *unless of such sectional area as will reduce the difference of potential between the ends of the insulated portion of the return below the limit laid down in Regulation* 7.

* 4. When any uninsulated conductor laid between or *within* 3 *feet* of the rails forms any part of a return, it shall be electrically connected to the rails at distances apart not exceeding 100 feet, by means of copper strips, having a sectional area of at least $\frac{1}{8}$th of a square inch, or by other means of equal conductivity.

* 5. When any part of a return is uninsulated, it shall be connected with the negative terminal of the generator, and in such case the negative terminal of the generator shall also be directly connected, through the current indicator hereinafter mentioned, to two separate earth connections which shall be placed not less than 20 yards apart.

Provided that in place of such two earth connections the company may make one connection to a main for water supply of not less than *three* inches internal diameter, with the consent of the owner thereof *and of the person supplying the water, and provided that where, from the nature of the soil or for other reasons, the company can show to the satisfaction of an inspecting officer of the Board of Trade that the earth connections herein specified cannot be constructed and maintained without undue expense, the provisions of this regulation shall not apply.*

The earth connections referred to in this regulation shall be constructed, laid, and maintained so as to secure electrical contact with the general mass of earth, and so that an electromotive force, not exceeding 4 volts, shall suffice to produce a current of at least 2 ampères from one earth connection to the other through the earth, and a test shall be made at least once in every month to ascertain whether this requirement is complied with.

No portion of either earth connection shall be placed within 6 feet of any pipe except a main for water supply of not less than 3 inches internal diameter which is metallically connected to the earth connections with the consents hereinbefore specified.

* 6. When the return is partly or entirely uninsulated, the company shall, in the construction and maintenance of the tramway (*a*) so separate the uninsulated return from the general mass of earth, and from any pipe in the vicinity; (*b*) so connect together the several lengths of the rails; (*c*) adopt such means for reducing the difference produced by the current between the potential of the uninsulated return at any one point and the potential of the uninsulated return at any other point; and (*d*) so maintain the efficiency of the earth

† The Board of Trade will be prepared to consider the issue of regulations for the use of alternating currents for electrical traction on application.

connections specified in the preceding regulations as to fulfil the following conditions, viz.:—

(i.) That the current passing from the earth connections through the indicator to the generator shall not at any time exceed either 2 *ampères per mile of single tramway line or* 5 *per cent. of the total current output of the station.*

(ii.) That if at any time and at any place a test be made by connecting a galvanometer or other current indicator to the uninsulated return and to any pipe in the vicinity, it shall always be possible to reverse the direction of any current indicated by interposing a battery of three Leclanché cells, connected in series, if the direction of the current is from the return to the pipe, or by interposing one Leclanché cell if the direction of the current is from the pipe to the return.

In order to provide a continuous indication that the condition (i.) is complied with, the company shall place in a conspicuous position a suitable, properly connected, and correctly marked current indicator, and shall keep it connected during the whole time that the line is charged.

The owner of any such pipe may require the company to permit him at reasonable times and intervals to ascertain by test that the conditions specified (ii.) are complied with as regards his pipe.

• 7. When the return is partly or entirely uninsulated, *a continuous record shall be kept by the company of the difference of potential during the working of the tramway between the points of the uninsulated return furthest from and nearest to the generating station. If at any time such difference of potential exceeds the limit of 7 volts, the company shall take immediate steps to reduce it below that limit.*

8. Every electrical connection with any pipe shall be so arranged as to admit of easy examination, and shall be tested by the company at least once in every three months.

• 9. Every line and every insulated return, or part of a return, *except any feeder*, shall be constructed in sections not exceeding half a mile in length, and means shall be provided for isolating each such section for purposes of testing.

• 10. The insulation of the line and of the return when insulated, and of all feeders and other conductors, shall be so maintained that the leakage current shall not exceed one-hundredth of an ampère per mile of tramway. The leakage current shall be ascertained daily before or after the hours of running when the line is fully charged. If at any time it should be found that the leakage current exceeds *one-half* of an ampère per mile of tramway, the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is *localised and removed within* 24 *hours. Provided that where both line and return are placed within a conduit this regulation shall not apply.*

• 11. The insulation resistance of all *continuously insulated cables used for lines*, for insulated returns, for feeders, or for other purposes, and laid below the surface of the ground, shall not be permitted to fall below the equivalent of 10 megohms for a length of one mile. A test of the insulation resistance of all such cables shall be made at least once in each month.

• 12. Where in any case in any part of the tramway the line is erected overhead, and the return is laid on or under the ground, and where any wires have been erected or laid before the construction of the tramway in the same or nearly the same direction as such part of the tramway, the company shall, if required so to do by the owners of such wires or any of them, permit such owners to insert and maintain in the company's line one or more induction coils or other apparatus approved by the company for the purpose of preventing disturbance by electric induction. *In any case in which the company withhold their approval of any such apparatus the owners may appeal to the Board of Trade, who may, if they think fit, dispense with such approval.*

13. Any insulated return shall be placed parallel to and at a distance not exceeding 3 feet from the line when the line and return are both erected overhead, or 18 inches when they are both laid underground.

14. In the disposition, connections, and working of feeders the company shall take all reasonable precautions to avoid injurious interference with any existing wires.

15. The company shall so construct and maintain their system as to secure good contact between the motors and the line and return respectively.

16. The company shall adopt the best means available to prevent the occurrence of undue sparking at the rubbing or rolling contacts in any place, and in the construction and use of their generator and motors.

17. In working the cars the current shall be varied as required by means of a rheostat containing at least 20 sections, or by some other equally efficient method of gradually varying resistance.

• 18. Where the line or return, or both, are laid in a conduit, the following conditions shall be complied with in the construction and maintenance of such conduit:—

(*a*) The conduit shall be so constructed as to admit of easy examination of and access to the conductors contained therein and *their* insulators and supports.

(*b*) It shall be so constructed as to be readily cleared of accumulation of dust or other *débris*, and no such accumulation shall be permitted to remain.

(*c*) It shall be laid to such falls, and so connected to sumps or other means of drainage, as to automatically clear itself of water without danger of the water reaching the level of the conductors.

(*d*) If the conduit is formed of metal, all separate lengths shall be so jointed as to secure efficient metallic continuity for the passage of electric currents. Where the rails are used to form any part of the return they shall be electrically connected to the conduit by means of copper strips, having a sectional area of at least $\frac{1}{10}$th of a square inch, or other means of equal conductivity, at distances apart not exceeding 100 feet. Where the return is wholly insulated and contained within the conduit, the latter shall be connected to earth at the generating station through a high resistance galvanometer suitable for the indication of any contact or partial contact of either the line or the return with the conduit.

• (*e*.) If the conduit is formed of any non-metallic material not being of high insulating quality and impervious to moisture throughout, and is placed within 6 feet of any pipe, a non-conducting screen shall be interposed between the conduit and the pipe, of such material and dimensions as shall provide that no current can pass between them without traversing at least 6 feet of earth, *or the circuit itself shall in such case be lined with bitumen or other non-conducting damp-resisting material, in all cases where it is placed within* 6 *feet of any pipe.*

(f.) The leakage current shall be ascertained daily, before or after the hours of running, when the line is fully charged, and if at any time it shall be found to exceed half of an ampère per mile of tramway the leak shall be localised and removed as soon as practicable, and the running of the cars shall be stopped unless the leak is localised and removed within 24 *hours.*

19. The company shall, so far as may be applicable to their system of working, keep records as specified below. These records shall, if and when required, be forwarded for the information of the Board of Trade.

Daily Records.

Number of cars running.
Maximum working current.
Maximum working pressure.
Maximum current from the earth connections (*vide* Regulation 6 (i.)).
Leakage current (*vide* Regulations 10 and 18 (*f.*)).
• *Fall of potential in return* (*vide Regulation* 7).

Monthly Records.

Condition of earth connections (*vide* Regulation 5).
Insulation resistance of insulated cables (*vide* Regulation 11).

Quarterly Records.

• *Conductance of joints to pipes* (*vide Regulation* 8).

Occasional Records.

Any tests made under provisions of Regulation 6 (ii.).
Localisation and removal of leakage, stating time occupied.
Particulars of any abnormal occurrence affecting the electric working of the tramway.

Railway Regulations.

The new regulations relating to railways insist that the iron or other metal plates forming the lining of the tunnels shall be so made and connected together as to form a continuous metal tube.

Where any pipe is brought into the tunnel from outside, means shall be provided to secure that no portion of the pipe outside the metal tube shall be in metallic connection with the tube or with any conductor of electricity within the tube.

When the rails form any part of the return they shall either be electrically connected, at intervals not exceeding 100 feet, to the metal tube by metallic conductors which will not be appreciably heated by a current of 100 ampères, or they shall not be in any metallic connection with the metal tube except by means of the connections to the negative terminal of the generator. In the latter case the rails shall be supported by cross sleepers of wood, specially prepared to resist the penetration of moisture and the growth of any mould or fungus, and they shall be of such sectional area and so connected at joints and from one line of rails to another, and where necessary to supplementary conductors or feeders, that the difference of potential between the rails and the metal tube shall not in any part and under any working conditions exceed 10 volts. A test of this shall be made at least once in each month.

In all other respects the rules relating to railways are included in those referring to tramways.

LEGAL.

Muirhead *v.* Commercial Cable Company.

(*Continued from page* 311.)

Fifth Day.—(Monday, March 5th.)

Mr. J. Swinburne said: I am an electrical engineer, and have devoted my attention entirely to electrical work since 1881. I have not had practical experience in telegraphy; my knowledge is by reading. But I have had practical experience in some of the instruments. The bridge in all its forms permeates the whole of measuring work. It is not a thing that is only known to advanced electricians. It makes no electrical difference how the resistances are made adjustable. Culley's handbook is very well known. I have seen the picture of the rheostat with the handle to it, to which his Lordship's attention has been called. That is an ordinary form of adjustable resistance. I have compared the 1880 and 1876 specifications. Fig. 1 in the two are electrically the same. There would be no substantial difference in the combination if the adjustment were done elsewhere in the bridge. In fig. 2 in the 1880 specification comes a change of extreme importance, that is, of placing the sending condensers in the bridge. The means of adjustment are the same.

There is no difference, I say, between the circular rheostat or that which works with plugs or straight wire. The word rheostat is not limited to any particular degree of resistance. There have been many forms of rheostats; all have been directed to taking out or introducing resistance. I believe Wheatstone first introduced the term. The essential part of fig. 2 is the insertion of the condensers in the bridge arm. Fig. 3 is the same as fig. 2 with the resistances reduced. I do not, as an electrician, see any difference between figs. 2 and 3 of 1880, and fig. 2 of 1876.

Cross-examined by Mr. Bousfield: I have no practical knowledge of duplex telegraphy. In 1876 I was serving my apprenticeship as an engineer, and I do not think I knew what duplex telegraphy was then. It may have been doubted for a good many years whether the problem in reference to duplexing would ever be solved as to submarine cables. Mr. Oliver Heaviside is an authority, and he intimated a doubt upon the subject. He had stated what he thought he himself would have understood in 1876 from the specification of that date. He considered that fig. 2 implied an adjustable resistance in the arms. He did not read the patent as indicating a fixed resistance.

Having regard to the state of knowledge in 1880, does not the specification give a final adjustment of the smallest kind which was never dreamed of being obtained so far back as 1876?—No, I think not.

Look at this description in Mr. Preece's book on telegraphy in 1876?—Yes, it is an admirable description of a simple duplex system. The adjustment there is obtained from what is called a rheostat, and he speaks of that which is placed in the arms as "known resistance."

I put it to you whether that is not really the same sort of arrangement as the patentee described in 1876?—Certainly not. In that case the rheostat arm takes the place of an artificial cable. As there is no question of capacity, there is no difficulty whatever in adjusting the resistance of the artificial line as a whole. There is no capacity adjustment to make.

Cross-examination continued: The 1876 patent includes the bridged condenser in combination with a receiving condenser. I do not know as a fact that the artificial line does not go to earth, but anyone reading the 1880 specification would, I think, put the cable to earth. It would not make any material difference either way. In my view there is no electrical difference between a resistance box and a rheostat.

Do you know that with a resistance box you would have to stop signalling while you were adjusting resistance?—No.

Mr. Moulton: That always has to be done.

Mr. Bousfield: I can assure my friend he has not understood this combination, if he thinks that is necessary. (To Witness): Assume that with this combination adjustment is being constantly made, without in any way interfering with the reception of signals, is that possible with the resistance box?

Mr. Swinburne: I think it would, although not with the dial form.

Assume that the use of bridge condensers that you say forms the essential part of fig. 2 in the patent of 1880 was then known in America, would not that alter your opinion?—No, because I cannot see what prior publication by the same inventor would have to do with it. If, however, condensers were old and well known, and if it was also known that they were not Muirhead's invention, then I should say the essential part might not be condensers.

Is it not a fact that while you can use the rheostat as an adjustable resistance, you cannot use any adjustable resistance as a rheostat?—Electrically, they are the same; but there is a mechanical difference of extra ease of adjustment in the rheostat.

Cross-examination continued: From fig. 2 of 1876, I infer a receiving condenser and the resistance as being low. Nearly the whole object of putting condensers in the bridge is to enable you to use a low resistance.

By Mr. Moulton: The special form of rheostat neither helped nor hindered the reduction of the resistance in any way. The specification permitted any convenient form of adjustment.

Mr. H. R. Kempe said he was attached to the engineer-in-chief's office at the Post Office under Mr. Preece. He was the author of various books in use by telegraphists. He was acquainted with duplex on its first introduction in 1873. He had looked at the 1876 and 1880 patents now in question. By fig. 1 in the 1876 specification, a competent electrician would have understood that there must be adjustment. The usual way would be to adjust the artificial cable, but you could adjust one arm or both. Circular rheostats were in use in 1872. Looking at fig. 2 of 1880, he thought the rheostat could be placed at the vertex, or at either of the arms. It was a matter of convenience. He had had no experience in working the duplex with submarine cables.

Cross-examined by Mr. Bousfield: It made no practical difference whether you place the rheostat at the apex of the bridge or in one of the arms, provided you had resistance in both arms. In his view, the rheostat was not an essential part of the combination. The clerk would not be able to alter the balance by means of it. It was unnecessary to have the resistances in the arms adjustable so long as you had condensers there. The bridge duplex system was not in use on land lines. Mr. Preece's book of 1876 referred to it. It was not necessarily used with fixed resistances in the arms.

In 1876 was there a single submarine line working successfully on the duplex system?—Yes; I think one to Gibralter. At that time the system was at its beginning.

In 1876 little was known about submarine duplexing?—That would be so.

Will you say that in 1876 the importance of having daily adjustment for small variations in submarine cables was known at all?—I think it must have been foreseen.

Can you point to anyone who recognised that it required a special apparatus to work cables with?—I do not know that I can.

It is only in long lines that it becomes important?—More important undoubtedly.

Further cross-examined, Mr. Kempe said that in the Post Office they used the differential system, and the receiving clerk had always to stop signalling when balance was being adjusted.

Mr. Preece, addressing the Institution of Electrical Engineers last year, said: "In 1877, though duplex key working on our landlines was fairly good, the imperfect balancing appliances at our disposal made working to Dublin very unsatisfactory, on account of stopping for signals." What was the length of the submarine cable to Dublin?—I think about 60 miles. The trouble was due to the length of the line, the combination of the land line with the cable.

Was it not due to imperfect balancing?—No doubt.

Mr. Preece speaks of the introduction of a receiving condenser in 1884. You have heard it suggested that a condenser is a thing that always was used with a receiving instrument?—In submarine cables I have always understood it was.

If it had been a matter of common knowledge in 1876, would the Post Office have delayed all those years?—You must bear in mind we were dealing with a combination of land and cable lines. An excessive speed was required.

Re-examined: On landlines they did not use bridge condensers, but condensers shunted by resistances. Upon the question of adjusting without stopping, it made no difference whether the rheostat was at the apex or in the arms.

Mr. John Gott, telegraphic engineer and electrician, said he was electrician to the defendant company. He had had 33 years' experience of submarine telegraphy. In 1876 any experienced electrician would have known, on looking at fig. 1 in the specification, that adjustments were necessary. In the 1880 patent the effects produced by the rheostat would remain the same.

Cross-examined by Mr. Finlay: He first used the duplex in connection with submarine telegraphy in 1872, between Newfoundland and Cape Breton. That line was about 300 miles. Upon a long ocean cable you would require a larger artificial cable and more sensitive instruments and adjustments. On a short cable you would probably not require temporary adjustments. It was in 1882 that he first had experience of duplexing across the Atlantic over 2,000 miles. The year 1884 was the date of the agreement that was the subject of the action.

Before the 1880 patent, how much faster were they able to work with the duplex than with the simplex system?—About 75 per cent. probably. Mr. Muirhead would know.

I suggest it was 35?—It was a good deal more.

The 1880 patent brought an increase of double?—No; from 10 to 15 per cent.

It would be 95 per cent. on the simplex?—Yes. We have obtained the results I have given by experimenting.

You found it worth while to use the 1880 patent?—Oh, yes.

In 1876, was there any general experience of duplex signalling for submarine purposes on cables of the length of those that cross the Atlantic?—I am not sure whether they had not it on the Aden cable at that time.

Did you use the resistance box on long cables before the 1880 patent?—Yes.

That was the system in use up to 1880 for adjusting a temporary derangement of balance?—No, not necessarily. We had the rheostat in conjunction with the coils in the bridge arms.

Did you always have the rheostat?—Yes.

Do you mean it was always in use in addition to this adjustable resistance box?—Yes.

On trans-Atlantic submarine cables?—Yes.

And if you were going to effect an adjustment by the use of this resistance box, in moving the plugs did not it involve stopping the current?—No, I do not suppose it would stop the current.

Did it not stop the transmission of messages?—Yes; because it would upset the balance.

Do you stop now?—It is better to stop the transmission, because you would only get a very rough balance.

Were you present at the trial prior to the agreement?—Yes.

There was no stoppage?—I do not think any readjustment was required.

By Mr. Moulton: They did not meddle with the balance while receiving. They adjusted before commencing work in the morning, and, if necessary, at other times. In his opinion, the increase of speed that had been obtained was produced by the condenser in the bridge arms. In 1876, the principle of adjustment by varying the bridge resistances was well known.

The hearing was adjourned.

Sixth Day (Tuesday, March 6th).

Mr. Frank Jacob said: I am an electrical engineer, and for the last 21 years have been in the service of Siemens Bros. & Co., Limited. For the last 15 years I have been their chief electrician. With regard to submarine telegraphy, I have had experience of the making of the instruments, the laying of the cables, and the way in which the instruments are worked. I was acquainted with the duplex system in 1876. In my opinion, the patent of that date implies that the resistances must be adjusted. It makes no difference how you adjust that resistance, whether it be by resistance box or rheostat. Electrically, there is no difference in any form of resistance. Circular instruments were used with plugs as well as with handles in 1876. For delicate work I should use plug resistances, because then I should be sure of the contact. The bridge condensers, as placed by the 1876 patent in the bridge arms, might be an advantage. There is no necessity to put the adjustable resistance at the apex of the bridge; in fact, he should prefer it not to be. It would work equally well at

one of the arms. When you are adjusting on a long cable you cannot go on receiving, on a landline you may. When you are signalling you get no movement of the needle on the receiving instrument.

Cross-examined by Mr. Pollard: I think there was duplexing with submarine cables before the 1876 patent. I am speaking now from what I have read, and would not pledge my recollection on the point. Experimentally, before 1876, I knew you could work on a cable with low resistances.

Is not the effect of a rheostat in adjusting temporary resistance not only to put some resistance in one arm, but to take some out of the other?—When it is used at the apex, yes.

When you have it in one arm does it do that?—No.

Further cross-examined: I should prefer the instrument by which the resistance is obtained to be at the arm rather than at the apex for practical working, because I should be able better to find out anything wrong on our side, such as a dirty contact. A dirty contact produces a greater resistance, and spoils the working. Before 1880 I had worked myself on an experimental cable with the resistance in one arm of the bridge, the bridge not being composed of resistance coils. If I only wished to put a resistance in, and not to know how much, I should use a rheostat, but, otherwise, a resistance box. I say the combination of 1880 is similar to that of 1876.

Had you ever heard of a combination having no resistance in the bridge arm, except that in the rheostat in conjunction with the two receivers, before 1880?—Yes; I have been told it was used by Prof. Jamieson and Mr. Sullivan.

Mr. Justice Kennedy: In 1876, was a condenser upon the arm of the bridge at the base of the triangle a common thing?

Mr. Jacob: It was.

Sir Henry C. Mance stated that he had been connected with submarine telegraphy since 1863. He had had large experience in every branch, and had filled numerous official posts. In his opinion, the 1876 patent conveyed the idea of adjustable resistance in fig. 1. Fig. 2 promised a great reduction of resistance by the introduction of condensers at the arms of the bridge. Arms of a bridge implied adjustment to an electrician. There was no question of principle involved in placing it either at the apex or at one arm. The 1880 specification, the patentee informed the public, he expected to use lower resistances. He was enabled to do that by the introduction of split condensers into the branches of the bridge circuit. Whether you used a box of resistance coils, or a rheostat of particular shape, made no difference excepting with reference to convenience of manipulation in this case, where the saving of a second was not of extreme importance.

Cross-examined by Mr. Finlay: In 1876, the duplex system for submarine purposes was in its infancy. It was valuable even before 1876.

The increase obtained by adopting the process of 1880 is very much greater than had been obtained by any other device previously?—The 1876 and 1880 are identical, I think. I should explain that in 1876 the Government decided not to introduce the duplex system in consequence of the bulk of the messages coming one way. I therefore ceased to take so much personal interest in it, but I have heard what has been going on. I prefer to speak as to the specifications.

Do not figs. 4 and 5 in the 1876 specification give you the means of obtaining a balance?—It may help you. There are other ways I could tell you of.

Fig. 11 specifies means of redressing temporary derangement of balance?—No; they are put in, as I understand, to make it more easy to obtain balance.

Mr. Moulton said that completed the evidence for the defence. He submitted the 1880 patent was the combination of the bridge condensers and the receiving condenser with the bridge arm equipped for adjustment. Everybody knew that the only thing in a bridge that was necessary was ratio. It would have been absurd to say that anyone was outside such a patent because he used a plug instead of a handle, or put resistance at one arm instead of at the apex. It did not matter how you made your adjustment when you had got your balance. According to what the plaintiffs were saying to-day, you could get the increase of speed just as well by arrangements entirely outside the patent. If Mr. Muirhead had been suing on the patent, the variation as to the particular position of the adjusting device would have been held to be immaterial in getting the benefit of the patent. Assuming the defendants had established that the special type of adjustment was not important—that the presence of an adjusting device was necessary, and that the pith of the patent was the presence in the position referred to of the three condensers, he (Mr. Moulton) turned to the 1876 patent and claimed the benefit of the United States law, which provided that if you had at an earlier date taken protection for an invention in countries other than the States, you were under this disability, that when once the patented invention got thrown open to the public in foreign countries, the American protection ceased. They would not have the American people deprived of the free use of the invention, when, by efflux of time, foreigners were entitled to it. The question was whether the patent here had been so patented at a prior date. In the 1876 patent he (the learned counsel) found two bridge arms, two bridge condensers, and the receiving condenser in combination expressly described and claimed. What was different? The word "adjustable" was not added to "bridge arms," but there was the concurrent testimony of witnesses on both sides that the essential idea of bridge arms and balancing implied that they were adjustable to get the balance, and that therefore any competent electrician reading the 1876 patent would obtain the very combination he (Mr. Moulton) had suggested as that which had been covered by the 1880 specification, because he would know that the bridge arms must be so formed as to be adjustable. The question had been asked whether the 1880 figured device had been used before 1880 to 1881? That was immaterial, because it was quite clear that the patentees did not use this part of their 1876 patent until 1880. The improvement that was then made was by their taking and adopting that bit of the older patent. The next point made was that there was a reduction of resistance in the arms. But the 1876 specification indicated how that might be effected, and the 1880 patent merely pointed it out rather more precisely and figured it.

On Wednesday, the 7th, Counsel addressed the Court, and his Lordship reserved judgment.

(To be continued.)

The Gold and Investment Trust Company, Limited, v. Electric Tramcar Company, Limited.

In the Chancery Division of the High Court of Justice on Friday, the 16th inst., Mr. Cuetice Price moved before Mr. Justice North for the discharge of Mr. Alfred James John Watson Smith, a prisoner who was committed to Holloway gaol on February 2nd last. From the terms of the order of committal, it appeared that the Court being of opinion that Smith had been guilty of contempt of Court in disturbing and interfering with the possession and right of possession of the receiver and manager of the property and assets of the defendant company, by removing from the premises certain plates, machinery, and other articles, committed Smith to prison, and directed him to pay the costs. Under that order Smith was arrested and lodged in gaol on February 24th last. The learned counsel said that Smith recognised that he had been guilty of a gross contempt of Court, and offered his apology, and to make such reparation as he could. Under these circumstances he asked his Lordship to make an order for the discharge of the prisoner.

Mr. G. F. Hart, for the plaintiffs, said he was instructed to inform his Lordship that, in the opinion of his clients, this was a rather premature application.

Mr. Justice North said that if the Court had been sitting next week he should have directed the application to stand over until then. The defendant had been arrested on February 24th, and he did not intend that he should be discharged before March 24th. He would make an order for the discharge of the prisoner on March 24th. As for restitution, he did not see what could be hoped for from a man who was an undischarged bankrupt, and of whom it was said that it was doubtful whether the plaintiffs would get their costs. The order must be in the usual form for payment of the usual costs, but he did not see why he should attempt to fix now that these costs should be payable by instalments.

The Edison-Bell Phonograph Company v. The London Phonograph Company.

In our last week's issue we stated that this action was adjourned to Friday last. When the Court resumed the hearing of the case,

Mr. J. Graham moved, on behalf of the plaintiff, for an interim injunction against the defendant, a Mr. Hough, who trades at 62, Old Broad Street, under the name of the defendants.

Mr. Hough appeared in person. He admitted that to a small extent he had been in possession of instruments which, to some extent, infringed; but he said he had altered his instruments by removing the recording point, and that the instruments in his possession did not now practically infringe the plaintiffs' rights.

Mr. Justice North said that there having been an admitted infringement, and the plaintiffs having obtained a judgment in one action, they were entitled to an interim injunction in general terms, but directed against the particular instruments in possession of the defendant.

Taylor v. Verity.

On Monday, in the Westminster County Court, this case came before his Honour, Judge Lumley Smith, Q.C., and a jury. It was an action brought under the Employers' Liability Act by John Taylor, a carpenter and joiner, to recover damages from Messrs. Verity & Sons, of King Street, Covent Garden, to recover damages for personal injuries which he alleged he sustained through the negligence of their foreman. While engaged at work in a lift, suddenly, without warning, the lift came down and smashed the plaintiff's hand. The negligence charged was that no warning regarding the working of the lift was given. The accident was on November 8th, 1893, and plaintiff had been able to do no work since. At the time of the accident he was earning £2 10s. a week.

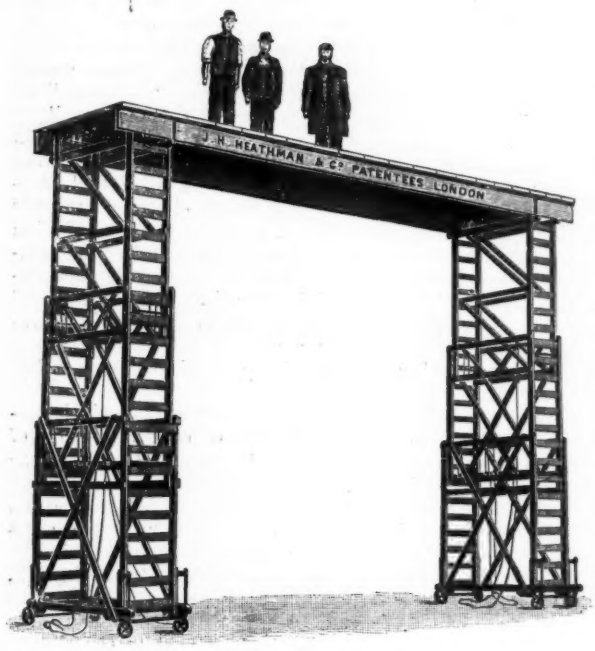
Mr. Tatlock, counsel for the defendants, submitted that plaintiff met with the accident through his own fault.

His Honour, having instructed the jury, they found for the plaintiff for £60, and his Honour gave judgment accordingly, with costs.

BUSINESS NOTICES, &c.

The Universal Electrical Directory (J. A. Berly's) for 1894.—Published by H. Alabaster, Gatehouse & Co., 22, Paternoster Row, London, E.C. This directory comprises the names of 18,414 different individuals and firms, is divided into four sections, namely, British, Continental, American and Colonial, each of these being sub-divided into alphabetical and classified sections. There are about 800 pages consisting entirely of directory matter, making the book the fullest, as it is the oldest, electrical directory in the world The price of the work is 4s., post free.

Portable Telescopic Scaffold.—We have already described the extension ladders as supplied by Messrs. J. H. Heathman and Co. for electric lighting and other purposes, and we now illustrate a telescopic scaffold on the same principle, recently supplied by the same firm to the Café Monico, Piccadilly Circus, for general use throughout the various rooms for cleaning and decorating the walls and ceilings. Each of the two tower ladders is 6 feet × 3 feet × 8 feet closed, and is easily taken apart to store in small compass; while



the bridge is formed of 2 joists on which are laid 1½ inch flooring in sections of 6 feet × 33 inches. The platform completed is 26 feet long × 6 feet wide, and rises to 19 feet 6 inches, so as to suit 25 feet ceilings; but the height is easily adjusted at any intermediate between 8 feet and 19 feet 6 inches. The extending mechanism consists of ropes over pulleys and operated by the hands without any complicated winches, while the rungs of the towers are locked fast by steel locks which fall under each rung as it passes upward. The rest of the construction is of Swedish fir.

Oldham Electric Lighting.—The electrical supply at the Oldham Corporation Supply Works was ceremoniously inaugurated on the 15th inst. The system adopted is the low-pressure two-wire. Prof. Kennedy is the consulting engineer. The contracts for the various work have been carried out as follows:—Erection of generating station, Messrs. S. & J. Smethurst; dynamos, engines, fittings, switchboards, instruments and connections, Messrs. Charlesworth, Hall & Co.; steam boilers, the Oldham Boiler Works Company; accumulators, &c., Crompton-Howell Electric Storage Company; economisers, Messrs. E. Green & Sons; insulators, Messrs. Doulton & Co.; cables, Messrs. Siemens Bros., Limited, and Henley Telegraph Works Company. The expenditure up to the present is as follows:—

Total tenders	£13,678
Service mains, conduits, &c.	6,000
Street lamps and meters	600
Balance owing	5,218
Total	£25,496

Burton Electric Lighting.—At a recent meeting of the Town Council Councillor Thornley asked if the chairman of the committee did not think it advisable to clear the air of rumours, anent the laying of the extra electric light mains in Station Street, and, if someone had blundered, to say on whom the expense of the error would fall. Alderman Lowe said he was very glad of the opportunity thus afforded of removing any misunderstanding that might exist. The contractors, Messrs. Fowler & Hammond, included in their tender cables to be laid in cast iron pipes of a certain size. When it was found that the tubes were not large enough, the contractors at once acknowledged their error, and agreed to bear the whole of the expense involved in laying another set of pipes, and in opening and re-laying the footpaths. The Corporation would be at no expense whatever; as a matter of fact, they would get more for their money than they contracted for. The loss amounted to £300, and the whole had been sustained by the contractors. It was a mistake of theirs, and not one on the part of the Corporation.

B. Verity & Sons.—This firm are now very busy with their electrical accessories. They are bringing out some new accumulator regulating switches, new double-pole main switches, and a whole series of new high insulation cut-outs,

Dover Electric Lighting.—At a recent meeting of the Town Council a letter was read from the local electric light company giving description of mode of lighting proposed. It was decided that the company be asked for a full report, specification, plans and estimate for laying on wires to Connaught Hall and Maison Dieu Hall, and to consult Mr. Chapple as to position and number of lights. The estimates received through Mr. Chapple were as follows:—

	Wiring.	Fittings.	Total.
Connaught Hall... ...	£308	£264 12s.	£572 12s.
Maison Dieu Hall ...	180	150 0	330 0

The committee considered the provision of permanent fittings advisable, and recommended that the former estimate only be approved and the latter stand over.

Private Installations.—Messrs. Gent & Co. of Leicester, have just completed the lighting of the printing, compositing rooms, and library of the *Folkestone Herald*. The plant consists of an 8-H.P. gas engine, Messrs. Gent's make of dynamo, and all fittings complete for an output of 80 lights of 16-C.P. The same firm have secured the contract for lighting the hotel Wampach, Folkestone. This plant will also be driven by a gas engine; the contract includes a set of accumulators, a G. & Co. dynamo, and all fittings for 150 16-C.P. Edison & Swan lamps, the principal rooms to be provided with elaborate electroliers. Messrs. Gent & Co. have also just completed a most successful installation for Messrs. Jermyn, Smith & Co., drapers, Peterborough. Not only are the company's drapery establishments lighted, but the adjoining shops and a bank. The motive power in use here is a gas engine and dynamo.

The Orient Electric Lighting Company, Limited.—A general meeting of the members of the above company will be held at 43, Finsbury Square, E.C., on April 21st, 1894, at eleven o'clock in the forenoon, for the purpose of having the liquidator's account laid before them, showing the manner in which the winding up has been conducted, and the property of the company disposed of, and of hearing any explanation that may be given by the liquidator; and also of determining, by extraordinary resolution, the manner in which the books, accounts, and documents of the company, and of the liquidation thereof, shall be disposed of.

Fire.—A fire occurred at Burnley last Saturday night in the premises occupied by Mr. J. Fletcher, electrician. The conflagration spread to adjoining premises, doing damage to the extent of nearly £3,000.

A committee of the Bradford Town Council had before it last week a case in which a fire is alleged to have broken out in consequence of defects in temporary electric fittings. The fire was promptly extinguished. A member of the firm of electricians concerned appeared before the committee and was cautioned.

Mill Lighting.—The electric light has been brought into use at Meltham Mills, Huddersfield. The installation is nearly completed, and consists of 1,400 lights of 16-candle-power each. The work has been carried out by Messrs. Ernest Scott & Mountain, electrical engineers, of Newcastle, under the management of Mr. F. Birchall, from the same firm. The plant consists of two 40-unit dynamos, driven by belting connected with the main shaft by two powerful engines coupled in parallel.

Colliery Lighting.—Rockingham Colliery (belonging to Messrs. Newton, Chambers & Co.), has lately been lighted by electricity. The plant, which lights the shops, engine-house, pit bank, and Silkstone pit bottom with incandescent lamps, consists of a 15 H.P. engine, and 12 unit compound-wound dynamo yielding 105 volts and 2,900 C.P. There are at present in use 64 16-C.P. lamps, 16 32-C.P., 2 60-C.P., and 7 200-C.P.

Electric Lighting of Blackpool Tower.—With regard to our note in last week's issue as to the contracts for the lighting of the Blackpool Tower, we find that the contract was secured by Messrs. B. Verity & Sons, of 29, Princess Street, Manchester, for the complete installation, and that Messrs. Siemens Bros. were successful in sub-contracting to them for the necessary dynamos. This installation, besides being very large, is an almost unique one.

Telephone between London and Dover.—Telephonic communication between London and Dover, as well as other places in Kent, was established last Saturday, by the National Telephone Company. The last connections were made between Greenhithe and Northfleet. Conversations exchanged between Dover, Canterbury, and London, were very satisfactory in regard to audibility.

Lists, Catalogues, &c.—From Messrs. O. Berend and Co. we have received a list which is intended as a supplement to their lubricator list. It fully describes the Hambruch patent lubricator system which we believe is meeting with great success abroad.

Messrs. Faraday & Son have sent us a list of their patent supports for electric candles.

Telegraphic Communication.—The new telegraph lines of the Pacific and European Telegraph Company, Limited, between Buenos Ayres and Valparaiso were opened on Monday last. In conjunction with the cables of the Eastern, Brazilian Submarine, and Western and Brazilian Telegraph Companies this affords a new direct telegraph route to Chili, Peru, and Bolivia.

Richmond Electric Lighting.—The Town Council have extended the time for the completion of the electric lighting works until May 1st.

Maidstone Electric Lighting.—The Local Board last week decided to transfer their electric lighting provisional order to a company.

Messrs. Blakey, Emmott & Co., Limited.—The creditors of the above company are required, on or before April 7th, 1894, to send their names and addresses, and the particulars of their debts or claims, and the names and addresses of their solicitors (if any), to James Lakeman, of 30 and 31, St. Swithin's Lane, E.C., the liquidator of the company.

Electrical Effects in Theatres.—We learn that the whole of the electrical apparatus as used in Mr. Oscar Barrett's pantomime, "Cinderella," is to be transplanted as a whole to Abbey's Theatre in New York. The pantomime is to be reproduced in New York on April 23rd.

Cheltenham Electric Lighting.—The Town Council have been recommended to accept the tender of Messrs. Galloway and Co., for two boilers for £439, and that of Messrs. Siemens Bros. and Co. for engines, &c., for £4,265. No decision has, however, been arrived at yet, the matter being adjourned for further consideration.

Electric Lighting in Ayr.—Ayr Town Council have resolved to ascertain the number of arc lamps required for lighting the town with electricity, also the amount of light needed by householders in the district.

Electric Light at Edinburgh.—At Daish's Grand Restaurant a dinner was given the other day on the occasion of the inauguration of the installation of the electric light in the buildings. The whole of the work has been carried out by Mr. Matthew Buchan.

Electric Lighting of Tramcars. — Messrs. Lea and Perrins, of Birmingham, have secured the contract for fitting up and supplying the electric light fittings for 300 tramcars that are being built in Birmingham for the Glasgow Corporation.

CONTRACTS CLOSED.

Brighton.—For the supply and laying of armoured and lead-covered electric cables for the Town Council. Tenders were received from the following firms: W. T. Henley's Telegraph Works Company, Limited; British Insulated Wire Company, Limited; Callender's Bitumen, Telegraph, and Waterproof Company, Limited; Fowler-Waring Cables Company, Limited (accepted); India Rubber, Gutta Percha, and Telegraph Works Company, Limited; Siemens Bros. & Co., Limited; W. T. Glover & Co.

Blackpool.—The Town Council, last week, resolved on the recommendation of the Electric Lighting Committee to accept the tender of Messrs. John Fowler & Co. for extension of the corporation electricity supply station, including boilers, engines, alternators, &c.

Yarmouth.—At a recent meeting of the Town Council tenders were opened for the laying down of the electric light installation. The lowest was Messrs. Crompton & Co., Limited, for £12,578 4s.; and the highest, Mr. H. South, for £19,624. The former was accepted. The surveyor stated that the total cost of the electric lighting works, according to the accepted tenders, would be £16,200, and as the loan sanctioned by the Local Government Board was only for £15,000 it was resolved to make application for sanction to borrow an additional £1,500.

BOOKS RECEIVED.

Water or Hydraulic Motors. By Philip R. Bjorling. Published by E. & F. N. Spon, 125, Strand, W.C.

A Standard Dictionary of the English Language. Vol. I., A to L. Published by Funk & Wagnalls Co., London and New York.

CHEMICAL ACTION A "REVERSED ELECTROLYSIS."

Notwithstanding the large amount of evidence now placed on record, that substances commonly supposed to be capable of directly inter-acting do so only in the presence of at least one other substance, no clear and consistent understanding of the conditions determinative of chemical changes has been arrived at. As each fresh case is recorded, surprise is expressed, overlooking the fact that Faraday, in his early "Experimental Researches in Electricity," clearly foresaw what the conditions were, and that but a slight extension of his generalisations is needed to frame a comprehensive theory. Eight years ago Prof. H. E. Armstrong defined chemical action as *reversed electrolysis;* in other words, in order that chemical action may take place, it is essential that the system operated on comprise an electrolyte. He pointed out that as neither oxygen nor hydrogen was an electrolyte, a mixture of only these two gases should not be explosive; and moreover, that as water was not an electrolyte, and it was scarcely probable that water and oxygen or hydrogen would form an electrolyte, it was difficult to understand how the presence of water pure and simple should be of influence in the case of a mixture of hydrogen and oxygen. This forecast has since been verified by V. Meyer, Krause, and Askenasy, whilst quite recently H. B. Baker, in a paper on the "Influence of moisture in promoting chemical action," has afforded several interesting examples.

The present state of this question was recently discussed by Prof. Armstrong, who modestly posed as desirous merely of attracting the attention of physicists, "to whom," he said, "we must now look for guidance in these matters."

Prof. Armstrong a short time ago raised the question whether there may not be a difference of actions taking place under the influence of low and of high E.M.Fs.—whether water, *per se*, may not be an electrolyte towards high, although not towards low, forces in the case of high temperature changes, or those brought about under the influence of the electric spark, for example. More attentive consideration has led him to think that this is not the case, and that high temperature changes, such as occur and are involved in gaseous explosions, must be treated in the same way as those occurring under ordinary conditions and at low temperatures.

The assumption of the presence of a "composite" electrolyte appears to be feasible in cases of chemical action, of which at least one function would be that of supplying the necessary mechanism whereby the degradation or discharge of the energy is effected. If this argument be sound, its logical extension involves the conclusion that pure gases should be dielectrics, *i.e.*, that the passage of an electric discharge through a gas like that of an explosive wave through, say, a mixture of hydrogen and oxygen, can only take place if an electrolyte be present.

Hitherto but little attention has been paid to the electric discharge in gases which have been highly purified. The peculiar behaviour of Tesla tubes, recently referred to by Mr. Crookes, may perhaps be explicable from this point of view. In causing a discharge to pass in these Tesla tubes, a difficulty is frequently met with; a tube through which no discharge would pass during several minutes, will suddenly become luminous, but only when charged dangerously near to the breaking point. Prof. Armstrong suggests that it may be that the atmosphere within the tube does not become conducting until sufficient moisture and "impurity" have been projected from its sides.

It is conceivable that a similar explanation may hold good in the case of Prof. Schuster's observation, that it is possible to urge a current of low electromotive force across a gas subjected to high electromotive force in itself insufficient to cause a discharge in the gas; the atomic dissociation hypothesis, which has been put forward in explanation of the phenomenon, does not appear to be sufficient.

Finally, Prof. Armstrong arrives at the questions: "Can no line be drawn? Are no two pure substances capable of combining?" Here there is little to guide us. Evidently more data are yet required, both of a physical and chemical nature, and the professor especially calls for information respecting simple electrolytes, such as whether fused silver chloride will cause chemical change in the way that water does; whether, for instance, silver chloride will effect the formation of hydrogen chloride from chlorine and hydrogen, so that a gas battery might be constructed of these three substances.

SHEFFIELD ELECTRIC LIGHTING.

The ceremony of opening the newly-erected station of the Sheffield Electric Light and Power Company, and switching on the current into the new mains, was performed by the Mayor on Saturday afternoon last. There was a considerable gathering of members of the corporation and other influential citizens. In the evening the invited guests were entertained at dinner by the electric light company; the chairman of

directors (Ald. G. Franklin) presiding, with the Mayor and Master Cutler supporting. The history of electric lighting in Sheffield dates back to 1885-86, when a pioneer station was started by Mr. John Tasker. Three years later, this property was acquired by the Sheffield Telephone Exchange and Electric Light Company, which in 1892, having disposed of its telephone business, changed its name and set about the business of lighting on a larger scale. The new building is well-designed for the purpose, and, as it covers a superficial area of 2,060 yards, and the present plant occupies only about a fourth of the floor space, there is ample provision for development.

The boiler house, which is 112 feet long by 35 feet wide, contains five Babcock boilers, each capable of evaporating 5,000 lbs. of water per hour, and a water heater, which will deal with 3,000 gallons of water per hour. Over the boiler house is a tank holding a reserve of 20,000 gallons. At the other end of the boiler house is the arc lighting plant, consisting of a horizontal compound jet condensing engine, belted to a countershaft supplying power to three Thomson-Houston arc lighting machines. Each machine will maintain 50 10-ampère lamps in series. The plant already put down for the incandescent supply consists of a row of four vertical engines, representing a total of 600 H.P., driving Mordey alternators.

One alternator carries an exciter on its shaft, and there are two separate exciters with engines. Foundations have been provided for an additional 500 H.P. plant, which it is anticipated will be required very shortly. A 10-ton travelling crane is thrown across one of the spans, and brackets have been cast on the metal stanchions supporting the middle span for another crane. In the engine house there is an office and testing room, also a meter testing room, storeroom, workshop, mess-room, and lavatories. The switches are interlocking, and can only be moved in their proper order, thereby rendering accidents from inadvertence on the part of the attendant impossible, and the whole operation necessary to secure synchronism is practically reduced to a mechanical process. A statement was made during the ceremony by the Mayor, which is interesting as giving expression to the reasons that influence corporations in their hesitancy to undertake electric lighting. Alluding to a remark of the chairman, that the Corporation might have retained the supply of electricity in their own hands, he said he thought the Corporation had quite sufficient work on hand to tax their energies and to occupy their time at present, and that the system would probably be more advantageously managed by a board of directors than by a committee of the Corporation. Seeing that electricity is in a progressive state, that it was liable to be affected commercially by the discoveries of science, he thought it best that the business should be taken up by a company of capitalists rather than that they should embark upon it with the ratepayers' money. If the company served them well they need not murmur, and he hoped the shareholders would have a satisfactory return upon their capital.

The General Electric Company of London availed themselves of the opportunity of demonstrating very effectively the advantages of cooking by electricity, the apparatus exhibited including ovens, grillers, kettles, and other utensils in operation.

NOTES.

Brechin and Electric Lighting.—A member of the Town Council has signified his intention to move that the council apply for an electric lighting provisional order.

Brighton Council Chamber and Electric Lighting.—As it is not improbable that somewhat extensive alterations to the Council Chamber may be shortly carried out, the Council have decided not to introduce the electric light into the present building in the meantime. If, however, it is decided not to alter the buildings, there is little doubt the light will be eventually installed in the present Chamber.

Fatal Accident.—It is reported from Innsbruck, the capital of the Tyrol, that a young man has met his death there by lifting from the ground an electric lighting cable which had been broken down by a heavy snowstorm.

Hermite Process.—A contemporary, the *Mechanical World*, commenting on the Hermite sanitary process much in the same vein as we have referred to it, states that "the positive electrode comprises brass rods having platinum gauze wrapped round them," and this error has appeared in other papers referring to the Worthing exhibition of the process. The positive electrode is platinum gauze or wire spirals, carried on rods of any material not acted upon by nascent chlorine; and that material, anyone ought to know, cannot be "brass." In fact, the rods in the electrolyser shown were "glass" rods. The negative zinc electrode was revolved so as to act as a stirrer, to combine the chlorine with the sodium and magnesium oxides immediately as they are formed.

Electrical Fog Signalling Apparatus.—We have received circulars explaining the main objects of Timmis and Abernethy's patent visual and audible and permanent recording electric fog-signalling apparatus. The details of the apparatus are not before us, but in principle we consider there is nothing new. We also much doubt the practicable working of anything of the kind. A locomotive is not a good place for electrical apparatus. Railway managers, as a rule, are averse to the employment of any form of apparatus for controlling the movement of trains which does not involve individual responsibility. The description given in the list sent to us is so meagre, that it affords no information whatever either as to the mode of working or how it is accomplished.

Telephone in India.—On the night of the 18th ult. the telephone was tried for the first time between Calcutta and Nagpur by the new 300-pound copper wire. The distance is 760 miles. The experiment went to prove that on such a circuit communication by telephone was perfect, but that contiguous telegraph wires interfered with the telephone. That, of course, would not be the case on a double-wire circuit, properly arranged. This is not the first instance of long-distance telephony in India. More than 10 years ago Kolhapur, in the Southern Mahratta country, used to exchange all messages by telephone, on iron wires, with Rutnajiri, Rajupur, and Chiplun, on the coast, upwards of 100 miles. The instruments were worked by native postmasters, and they were remarkably successful from the outset. The atmospheric disturbances proved a great hindrance. The hissing and crackling sounds in the telephone during the afternoons almost overpowered the sound of the voice. The Morse system was subsequently introduced into all postal telegraph offices in India, and these early telephones were removed. Copper wires have since then proved their superiority over iron for long telephone circuits, for reasons well known.

Communication with Lightships.—Electrical communication with the first of the lightships recommended by the Royal Commission of last year—the Kentish Knock—was completed on the 14th inst. under the personal supervision of Mr. Lumsden, the Submarine Engineer of the General Post Office. The *Times* of the 20th inst. publishes a somewhat lengthy article on the subject, from which it appears that the only novelty is in the method of mooring the lightship. Four anchors have been laid down at the corners of a square, and from these 1½-inch chains, each 210 fathoms long, run to the lightship; the direction of the chains being N.E., S.E., S.W., and N.W. Their ends are connected by a special shackle, invented and patented by Mr. Bedwell, of the Telegraph Construction and Maintenance Company, through the centre of which a specially constructed cable passes up to the lightship. The *Times* fears that the weight of the four chains, when the ship is hove short, may prove dangerous, but we believe there is no reason why the shackle should not be lowered to the bottom, and the ordinary scope of single chain given. No damage to the cable was found to result from this in the case of the Sunk Lightship, although, through her windlass being inefficient, considerable lengths of chain and cable were often together on the bottom for long periods of time.

Bromley and Beckenham Electric Lighting.—The Beckenham Local Board has asked the Bromley Board to appoint a small Committee to consider the advisability of a joint installation of the electric light.

Accident.—An electric light engine driver in the employ of the Midland Railway, at St. Pancras, last Saturday, met with a serious accident through the ladder upon which he was standing, while cleaning the engine, slipping, and throwing him to the ground.

The Electric Mains of the Compressed Air Company, Paris.—The Compressed Air Company are continuing the re-laying of their whole electric canalisation in Paris. They have recently laid Siemens cables along the Boulevard des Italiens, from the Rue de Graunnout to the Rue de Richelieu. Fresh cables have also been laid along the Boulevard Sebastopol in the wooden troughs previously in use. They have, moreover, sent in 22 petitions to the Municipal Council with regard to other plans for electric mains in various quarters.

Lectures.—Mr. F. F. Bennett, M.I.E.E., of the firm of Bennett & Druce, delivered a very interesting lecture before the Preston Scientific Society at the Guildhall, on Tuesday, the 13th inst., entitled, "What is a Board of Trade Unit?"

A lecture was delivered on 6th inst. under the auspices of the Middleton Scientific and Literary Society in the Middleton Town Hall, by Mr. F. L. Striffler, on "Electric Light and Power Distribution."

Mr. W. J. Alexander, on 13th inst., delivered a lecture on "Electricity Produced by Influence Machines," at the Station Road Schools, Teddington.

Explosion at Preston.—On Saturday last, about 11.45 p.m., an explosion occurred in the electric light mains in Lancaster Road, between High Street and Saul Street. The parapet was disturbed by the shock, but no one was injured. The manager of the company was at once informed of the occurrence, and he quickly had the length cut out, and the supply was only interrupted for about an hour. A local paper says the explosion is supposed to have been caused by water which had leaked into the culvert from one of the Corporation valves coming into contact with the copper conductors, and so causing a spark, which exploded a quantity of gas in the main.

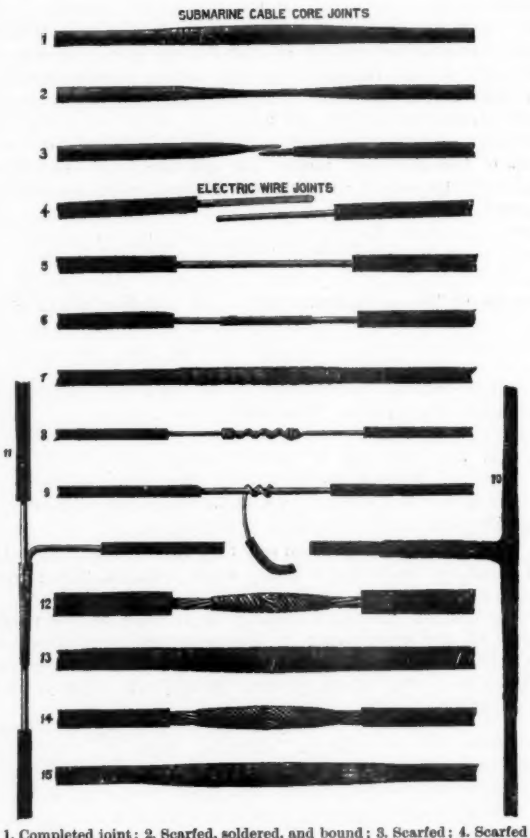
The Institution of Electrical Engineers.—At the meeting to be held on Thursday, March 29th, 1894, the balance-sheet for 1893 will be presented. The discussion "On Parallel Working through Long Lines," by Mr. W. M. Mordey, will be continued. The following papers will also be read: 1. "A Universal Shunt Box for Galvanometers." 2. "Transparent Conducting Screens for Electric and other Apparatus." 3. "An Astatic Station Voltmeter." These are by Prof. W. E. Ayrton, F.R.S., Past-President, and T. Mather, Associate. 4. "The best Resistance for the Receiving Instrument with a Leaky Telegraph Line," by Prof. W. E. Ayrton, F.R.S., Past-President, and C. S. Whitehead, M.A.

Central Telephone Station in Paris.—The central telephonic office in the Rue Gutenberg has now been opened some time. There are more than 2,000 subscribers, and in a short time the number of users will be increased to 6,000. This office alone will supply half the subscribers of the city. It is hoped therefore that the service will be carried on under the best conditions as to clearness and quickness. We do not wish to express any opinion at present, but we will merely say that the telephone service has lately left much to be desired, and that there is great need of improvement. We hope that when the service is fully organised, the Administration of Posts will communicate particulars as to the new installations to the technical press. The service for long distance communications with London, Brussels, Lyons, Havre, Rouen, Marseilles, Bordeaux and Lille is also worked from the same central office.

Electric Lighting of Derry.—On Wednesday, last week, the electric current was turned on in two of the divisions, and was very successful.

Royal Institution.—The following appear among the lecture arrangements after Easter:—Prof. J. A. Fleming, four lectures on "Electric Illumination; Prof. Dewar, three lectures on "The Solid and Liquid States of Matter." The Friday evening meetings will be resumed on April 6th, when a discourse will be given by Prof. Victor Horsley, on "Destructive Effects of Projectiles." Succeeding discourses will probably be given by Prof. J. J. Thomson, Dr. J. G. Garson, Prof. H. Marshall Ward, Dr. G. Sims Woodhead, the Rev. S. Baring-Gould, Prof. A. M. Worthington, Sir Howard Grubb, Prof. Oliver Lodge, Prof. C. V. Boys, and other gentlemen.

Joints as they should be.—Perhaps it may interest our readers to see "A Specimen set of the Submarine Cable and Electric Light Wire Joints," which each of Prof. Jamieson's students at the Glasgow and West of Scotland Technical College have to make during their course there. The set illustrated was made this session by a young man, Mr. Stephen Hutcheson, who has never been in any other



1. Completed joint; 2. Scarfed, soldered, and bound; 3. Scarfed; 4. Scarfed; 5. Soldered; 6. Soldered and bound; 7. Completed joint; 8. Simple twist joint; 9. Twist T-joint; 10. Completed T-joint in stiff wire; 11. T-joint for stiff wire; 12. Married joint in stranded conductor in 7 No. 16's; 13. Completed joint; 14. Married joint in stranded conductor; 15. Completed joint in stranded conductor, 19 No. 18's.

workshop or laboratory. We must confess that if all joints were as well made there would be more room for congratulation and less for fault-finding. Such exercises ought to be of very great service to young men, for not only do they start the student from a high ideal standard, but they ensure his being of practical use in the workshop when he enters upon his apprenticeship. A young electrician should not only be able to make quick and reliable tests, but he should be capable of replacing the jointer or wireman, &c., at a moment's notice.

NEW COMPANIES REGISTERED.

Electricity Users' Association, Limited (40,677).—This company was registered on the 9th inst. with a capital of £2,000 in £1 shares, to insure against all kinds of accidents to electrical apparatus generally, to replace broken or worn out parts, lamps, &c., with new; to make all necessary repairs, and to keep up installations to as high a standard of efficiency under competent inspection as is possible. The subscribers (with one share each), are: A. E. Samuell, 35, Bucklersbury, E.C., solicitor; W. T. Lawrence, Millom, Cumberland, solicitor; J. N. Winch, 6, Overhill Road, S.E., articled clerk; G. H. Smith, 57, Ebury Buildings, S.W., solicitors' clerk; R. H. Behrend, 38, Arundel Gardens, W., solicitors' clerk; G. Earle, 15, Achilles Road, N.W., managing clerk; W. H. Page, Ash Cottage, Putney, stationer. The number of directors is never to exceed 7; qualification, 20 shares; remuneration, £10 per cent. per annum of the net profits. Registered by Windybank, Samuell & Behrend, 35, Bucklersbury, E.C.

Oriental Telephone and Electric Company, Limited (40,691).—This company was registered on the 12th inst. with a capital of £200,000 in £1 shares, to acquire the undertaking of the Oriental Telephone and Electric Company, Limited, now in liquidation, and to carry on this business in all its branches. The subscribers (with one share each) are:—Wm. Addison, 79, Belsize Park Gardens, N.W., share dealer; T. Lloyd, 99, Earl's Court Road, W., journalist; G. B. Frost, 38, Highbury Hill, N., merchant; A. B. Chalmers, Hazeldean, Cassie Road, Watford, secretary; B. St. John Ackers, Huntley Manor, Gloucester, barrister at law; H. A. Hentsch, 8, Petworth Street, Battersea, clerk; H. Grëwing, 26, Queen Anne's Gate, S.W., merchant. The first directors are Wm. Addison, B. St. John Ackers, H. Grëwing, T. Lloyd, and G. B. Frost; qualification 1,000 shares of the *original* capital of the company; remuneration, £1,500 per annum divisible. Registered office, 14, Austin Friars, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Consolidated Telephone Construction and Maintenance Company, Limited.—This company's annual return shows that out of a nominal capital of £307,545 in 75,000 £1 6 per cent. preference, 224,850 14s. ordinary, and 75,150 £1 ordinary shares, 27,637 preference and 224,850 14s. ordinary shares have been taken up. The sum received is £185,032.

North Eastern Telephone Company, Limited.—The statutory return of this company shows that out of a nominal capital of £1,000 in 500 preference and 500 ordinary shares, all of £1 each, 15 preference and 452 ordinary shares have been taken up, and that 6s. has been called on 28 ordinary and 5s. on each of 15 preference shares. The total amount received is £12 3s., and £316 8s. has been agreed to be considered as paid.

Domestic Telephone Company, Limited.—This company has been dissolved under Clause 7 of the Companies' Act, 1880, by notice in the *London Gazette*.

Woodfield Syndicate, Limited.—The last yearly return of this company shows that the whole of the nominal capital of £12,000 has been taken up and paid in full.

Belfast Electric Appliances Company, Limited.—This company has been dissolved. The last annual return shows that the nominal capital was £20,000, in 1,900 "A" and 100 "B" shares of £10 each, and that only 100 shares were taken up. A sum of £1,010 was agreed to be considered as paid.

Chelmsford Electric Lighting Company, Limited.—This company's yearly return shows that out of a nominal capital of £10,000 in 7,500 preference and 2,500 ordinary shares of £1 each, 5,507 of the former class and 2,378 of the latter have been taken up, and that the full amount has been called. A sum of £7,878 has been received, and there is only £7 outstanding.

Eastern Telegraph Company, Limited.—The annual return of this company was filed at Somerset House on the 8th inst., and shows that out of a nominal capital of £4,700,000, divided into 400,000 ordinary and 70,000 preference shares of £10 each, 469,988 shares have been taken up, that the full amount has been called, and all calls duly paid.

Cuba Submarine Telegraph Company, Limited.—The annual return of this company, made up to the 28th of last month, shows that out of a nominal capital of £220,000 in 16,000 ordinary and 6,000 preference shares all of £10 each, the whole of the shares have been taken up and fully paid.

Electric Meter Company, Limited.—The last return of this company shows that out of a nominal capital of £50,000 in £10 shares, 2,007 shares have been taken up, and that the full amount has been called on 7 of these. A sum of £30 has been received in response to calls, £20,000 having been agreed to be considered as paid, and £40 is still outstanding.

Tayler Smith Electric Company, Limited.—This company's last annual return shows that out of a nominal capital of £6,000, in 300 preference and 300 ordinary shares of £10 each, 299 preference and 300 ordinary shares have been taken as paid. The full amount has been called on the preference shares, £2,980 has been received in response to calls, £3,000 has been agreed to be considered as paid, and £10 is outstanding.

Sunbeam Lamp Company, Limited.—The yearly return of this company was filed at Somerset House on the 17th inst., and shows that out of a nominal capital of £25,000 in £10 shares, 1,600 shares have been taken up, that £8 has been called on each of 455 shares, and £10 on each of 288 shares. A sum of £6,490 has been received; £8,570 has been agreed to be considered as paid, and £30 is outstanding.

CITY NOTES.

New Issues.

We had only time to briefly notify last week the reformation of Messrs. Willans & Robinson's, with an increased capital. An immense business has been done in Willans engines during the past three years, and no doubt it is reasonable to expect as great a demand, if not greater, in the next few years. At the same time fashions are liable to change even in engines, and just as the Willans superseded the Brotherhood, and to some extent the Chandler, for electric lighting, so may the Willans engine be succeeded by a new form of motor. We are not anticipating any such important change, but we are by no means likely to stand still. Willans & Robinson are not altogether dependent on electric lighting, however; they have succeeded in establishing a prestige among users of steam engines for general purposes. In fact, it was always surprising and gratifying to us to see the Willans engines obtaining a strong position among mill owners. There is every reason to anticipate, especially with the opening up of new branches of work, that the shareholders in Willans & Robinson will be satisfied with their future dividends.

Another issue which we have to notice is that of the Waterloo and City Railway Company. Our readers are no doubt aware that this company has been formed to erect an underground railway, worked by electricity, between Waterloo and the Mansion House. There will be no intermediate stations, and the journey will take four minutes. The capital of the company is share capital, £540,000; borrowing powers, £180,000. Applications are invited for 54,000 shares of £10 each, £1 payable on application, £1 on allotment, and the balance in four calls of £2 each. Interest at 3 per cent. per annum will be payable out of capital during construction. The agreement between the Waterloo and City and South-Western companies provides that the latter will work the railway at cost price, and that interest at the rate of 3 per cent. per annum on the whole of the authorised capital, whether it be raised by the issue of shares or debentures, shall be a first charge on the gross receipts of the undertaking before any deduction whatever is made for working expenses.

All receipts, from whatever source, after payment of 3 per cent. above referred to, and working expenses, will be divided as follows:—Two-thirds to the Waterloo and City Company, and one-third to the South Western Company.

There is every reason why this undertaking should be successful, though the underground construction will be expensive.

Another issue—or, we should say, issues—are those of the Hove Electric Lighting Company, which is issuing a balance of 3,954 ordinary shares of £5 each, as well as five per cent. first mortgage debenture bonds for an aggregate amount of £12,500, being half the authorised debenture capital. This issue is noticed lower down. The report of this company, published in our last issue, was an exceedingly good one, and there is every prospect of a successful career.

Oxford Electric Company, Limited.

Although this company does not show much profit, we think there is very little to grumble about. We gave last week the main features of the report, this week we are able to set forth the cost of generation. The cost of coal is exceedingly low, and the engineer, Mr. Hardie McLean, is to be congratulated on his management. The wages and management figures out rather high, but the present staff could no doubt meet a large output. A good deal is spent on maintenance, but a depreciation account has not been commenced. The total cost per unit is 5·7 against 7·2d. received.

	1891.	1892.	1893.
Total capital invested... ...	—	—	£58,107
Number of units sold	—	—	103,895
Number of lamps connected ...	—	—	7,012
Revenue from sale of current...	—	—	£3,141
Net revenue	—	—	—
Average price obtained per unit	—	—	7·26d.

Cost of Production.	£		Per unit.
Coal	311		·71d
Oil, waste, water, and engine room stores	28		·06d.
Salaries and wages at generating station	596		1·38d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	580	(Works cost 2·49d.)	1·34d.
Rates and taxes	220		·51d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance.. ..	729		1·68d.
Depreciation of buildings and plant account	nil		—
Renewal fund account	nil		—
Total	£2,467		5·7d.

Revenue.				Average price obtained per unit.
By sale of current	3,141	0	0	—
Meter rents	68	0	0	7·26d.
Profits on installations	346	0	0	—
Total	£3,555	0	0	7·26d.

Total cost per unit, 5·7d.; works cost, 2·49d.

The London Refuse Steam Generator and Electrical Power Corporation.

The promoters of the Livet system have followed up their demonstration at Halifax by issuing a prospectus. The public is asked to subscribe £600,000 to acquire the rights for London and 20 miles round of working Livet's patents for destroying town refuse, and for rapid generation of heat in furnaces.

It will be remembered that a month ago we gave an account of a visit to Halifax, where the Atlas Syndicate demonstrated to the satisfaction of some newspaper reporters that a revolution had been effected in the utilisation of town's refuse. Our views as to the uselessness of this demonstration were clearly set forth. We concluded an article with the significant warning that:—"Before attempting to interest capitalists and electricians in their projects, the Atlas Contracting Syndicate ought to subject their inventions to rigorous tests, and have the results vouched for by some well known authority on boilers, furnaces, flues, and steam generating. It would be an insult to the engineers present to expect them to accept the Halifax display as a proof of the claims put forward for the process; the demonstration was little short of an extravagant farce." We might have gone further than that, but we deemed it fair to wait for the Livet people to put forward some reliable figures. We have not yet seen these figures and the prospectus gives the most meagre information concerning the burning of refuse by the Livet furnace. It cannot be denied that the prospectus makes a good deal of the results achieved at Halifax. It states that the Livet furnace has run successfully at Halifax for many months, where an installation, capable of producing 250,000 electric candle-power, has conclusively proved its value. There are, of course, differences of opinion as to what constitutes a successful run. On the occasion of our visit to Halifax, we saw that the 250,000 represented the combined candle-power of a search and some arc lights. Now, it should not be forgotten that the 250,000 C.P. in the shape of arc and search lights was produced from a 32 unit machine; surely such a paltry test, with a huge boiler under full steam when the party arrived, cannot be expected to satisfy practical men. Why did not the promoters of this magnificent scheme of providing light by destroying refuse demonstrate what they could do with London refuse; this, at least, is expected from a company whose work is to be confined to London and a small area round it. If the system were all that its promoters claim it to be, such trials and expenditure were justified, and if the results could then have borne examination, we, as well as thousands more, would have welcomed the scheme as the grandest invention of the age. Instead of this, we are expected to be satisfied with opinions more or less vague. Elaborate and careful tests as to what the Livet system could do may have been carried out, but where are the figures? One gentleman makes out certain facts about London refuse, the horse-power that could be obtained from it, and the value of refuse to the London ratepayer; but these statements cannot be considered seriously for a moment. We are not going so far as to say that the Livet boiler may not burn low class fuel; but our impression is that the refuse which was on exhibition at the Halifax demonstration was a rather high class fuel than otherwise.

With regard to the tests made on the Livet furnace, we feel tempted to give an extract from our contemporary, *Engineering*, which, on the occasion of the Halifax demonstration, said that "We must express our utter disbelief in boiler tests made by persons unaccustomed to such trials. . . . . The record of a boiler trial is like an oil painting; its value depends on the name with which it is signed." Further, our contemporary remarks that "if the Livet boiler will burn refuse without smell or smoke, we unhesitatingly affirm that a Cornish boiler will do the like. For, from the point of view of combustion, it is only a Cornish boiler." We will make another extract: "In view of the great difficulty of attaining satisfactory results when the combustion takes place in a glowing brick vault, we do not believe that success can be obtained in a boiler, except with picked materials."

There is one statement in the prospectus to which we must draw attention. It is said that "By the Livet process 3 tons of rubbish can produce the same amount of steam power as is now obtained from 1 ton of the best coal." There is nothing to show how far this statement is correct; but we will compare it with a statement in another part of the report. Mr. Bayly Marshall, in his report to the company, said that in the Livet furnace "undried rubbish can be burnt in such a manner, as to produce heat enough to evaporate nearly 2 lbs. of water per gross lb. of rubbish." Now Mr. Fletcher's tests of Lancashire boilers, which are quoted in the report, shows that 1 lb. of coal will evaporate 10·77 lbs. of water, so we are face to face with the fact that

1 lb. of rubbish evaporates 2 lbs. of water.
1 lb. of coal evaporates 10·77 lbs. of water.

Mr. Marshall's figures, therefore, showing that coal has five times the value, instead of three, set forth in the prospectus in large type. We are told that the probable profits will amount to £515,500 per annum; this assumes that the Livet system will supplant most other steam-producing plant. The moderation of such an estimate will appeal to the investing public. After such a glowing description of what the system can do, we are not surprised to learn that the price to be paid for the right to work the invention in and around London is £400,000, but to show the confidence of the vendors they agree to take £200,000 in shares and the rest in cash.

Considering the comprehensive title of the company, it would be interesting to know why eminent electrical men, who, in addition are engineers, such as Prof. Kennedy, Mr. Ferranti and Mr. Crompton, all large users of steam, were not consulted as to the adaptability of the system to electric lighting purposes.

Eastbourne Electric Light Company.

We are able to congratulate this company upon an increase in the number of lamps, and upon a fairly successful year.

The gross profit for the year, after allowing a further sum of £400 for depreciation, is £1,981, which, after paying interest on debentures and mortgages, leaves a balance of £824. It is proposed to pay a dividend of 5 per cent., which leaves a balance of £315 for the directors.

The reserve fund account now amounts to £1,425.

We notice that the company is seriously thinking of extending the area of supply, and it is proposed to issue debentures for about £6,000. The money is being subscribed privately.

The analysis of the cost of generation is as follows:—

	1891.	1892.	1893.
Total capital expended	£27,200	£37,200	£37,950
Number of units sold	—	—	124,663
Number of lamps connected ...	—	—	8,454*
Revenue from sale of current ...	—	—	£4,560
Net revenue	—	—	—
Average price obtained per unit..	—	—	8·7d.

* 21 arc lamps not included.

Cost of production.	£		Per unit.
Coal	742		1·43d.
Oil, waste, water and engine room stores	79		·15d.
Salaries and wages at generating station	803		1·54d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	379	Works cost 3.75d.	·73d.
Rates and taxes	225		·43d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	489		·94d.
Depreciation of buildings and plant account	400		·77d.
Renewal fund account	nil		—
Total	£3,119		6·00d.

Revenue.				Average price obtained per unit.
By sale of current	4,560	0	0	—
Meter Rents	171	0	0	8·7d.
Installations	353	0	0	—
Total	£5,084	0	0	8·7d.

Total cost per unit (exclusive of depreciation), 5·23d.; works cost, 3·75d.

Yorkshire House-to-House Electricity Company, Limited.

The first annual meeting of the Yorkshire House-to-House Electricity Company, Limited, was held on Tuesday, 6th inst., at the electric lighting station, Whitehall Road, Leeds. Mr. Grosvenor Talbot (chairman) presided.

The Chairman moved the adoption of the report. He said that since their last meeting on May 12th of last year the directors had had not only a busy and laborious time, but a time of considerable anxiety. They had to establish the company, and they had suffered anxiety on account of the constant increase in their plant that was necessary. On the work of the last eight months they had been able to show a profit of £1,155. That was most satisfactory to them, considering that the months of May, June, July, and August were the months of the longest days, when lighting was little required. They had really only four months of good lighting, and they certainly had not done badly in making the profit they had done. The directors had thought it better that they should reduce the amount of the preliminary expenses account, and they had applied £1,000 for this purpose. He did not think that in another year they would be called upon to apply a similar amount. They had had to contend with two difficulties. There had, in the first place, been one of the brightest winters and autumns on record, which meant a great many hours less lighting. Then there was the coal strike. The lamps had been put in in small numbers until they got to the maximum amount in the dead of winter, and they had found that unless they took the proper steps they should not be able to supply their customers. In Leeds, the number of lamps burning was, compared with the number of lamps in store, larger than in any other district. In other stations they reckoned to have twice as many lamps as they had burning, but in Leeds they had three-fourths of their lamps going at the same time. Referring to the increase in the horse-power, mentioned in the report, the Chairman said it became necessary for the directors to consider what would be their position in the following winter, for they knew that there were several large buildings in course of erection in the city which were depending upon electric lighting directly they were opened. It had been growing upon the directors month after month that the value of the site of the station was almost incalculable; it was in such a wonderfully good position, close to the centre of the town, and they felt the necessity of making the best use of that excellent site. They had increased by 1,100 horse-power, and they anticipated that next winter their strength would be 1,800 horse-power, for they expected to have more lighting than they had last year. They had made the Corporation an offer to supply the Town Hall and the municipal buildings with electric light at a considerably less cost than appeared in the published accounts of the County Council. Some of their customers had suggested that the price of electricity was high, but they intended next April to reduce the price by 12½ per cent. He confidently believed that the price of electricity, paradoxical as it might seem, lay more in the hands of the inhabitants of Leeds than with the directors, because with a progressive demand they should be able to give successive decreases until they got it down to a reasonably small figure. The initial expenses of starting the electric lighting station had been heavy, but afterwards the decrease was most remarkable. They had made a very fair start, and he had confidence that they should be able to have in Leeds a large, paying, and thrifty electric lighting establishment.

Mr. G. H. Crowther seconded the motion, and the report was adopted.

Mr. Samuel Ingham and Mr. Arthur Greenhow Lupton were re-elected directors of the company, and Mr. John Gordon, jun., was re-appointed auditor.

Direct Spanish Telegraph Company, Limited.

The ordinary general meeting of this company was held on Tuesday at Winchester House, Sir John Pender, M.P., presiding.

The Chairman, in moving the adoption of the report, said the accounts for the half-year showed that after providing for debenture interest there was a balance to the credit of the profit and loss account of £4,996. The traffic receipts showed a decrease of £509 as against the corresponding period of the previous year. The falling off in the receipts was due to the general depression which had prevailed, but he was happy to say that at the present time there were signs of a slight improvement, and he honestly believed they would see good times come round again. Telegraphic companies were happily affected by the depression to a smaller extent than other undertakings. The decrease in the working expenses was a small sum, and was one of the changes incidental to the working of a company. Their cables and land lines had, with one exception, continued in good working order throughout the half-year. The cost of the repairs which had been necessitated, amounting to £1,453, had been taken from the reserve fund, and it was intended to repay the amount to that fund out of future profits. The interruption caused by the only break which took place only lasted eight days, and that was the shortest time on record under that head, while the sum charged for repairs was the smallest expenditure ever incurred for such a purpose. After adding the usual sum of £2,500 to the reserve fund, the balance to profit and loss amounted to £2,496. Out of that amount the directors recommended the payment of a dividend at the rate of 10 per cent. per annum on the preference shares, and at the rate of 4 per cent. per annum on the ordinary shares.

The report was unanimously adopted.

Pontypool Electric Light and Power Company.

The annual general meeting of the shareholders of this company was held at the company's office on Friday last, Mr. W. Pegler, J.P., presiding. The directors' report reads as follows:—

"Since the last report, which was issued up to September 30th last, seven new customers have been added, making a total of 29 in all now attached to the company's system. The working of the station for the five months ending on December 31st has resulted in a net profit of £127 11s. 3d., which the directors propose should be divided as follows:—A sum of £50 be placed to the reserve account; £30 allowed for depreciation of buildings, machinery, and mains; and a dividend on the paid up capital at the rate of 2½ per cent. per annum for five months be declared, absorbing £120 8s. 2d., leaving a balance of £7 3s. 1d. to be carried forward to next year's accounts. The directors are anxious to make the financial year of the company end on December 31st, so as to be in accordance with the custom observed by other companies of similar character."

The report and accounts were adopted.

Madras Electric Tramways Company.—At a meeting of shareholders of this company, held on February 16th, Mr. Chalk, managing director, presided. A great deal of opposition was manifested by the shareholders who had not paid their calls and who were requested to retire, and on their refusal a police inspector was sent for, but ultimately they were allowed to remain on condition that they did not speak or vote. A discussion took place on the proposition that a local advisory board be formed. The discussion was of a very acrimonious nature, but after several amendments had been defeated a proposition was carried, and a representative board was appointed.

The Hove Electric Lighting Company.—This company, which has a capital of £40,000, in 8,000 shares of £5 each, of which 4,046 have been allotted, invite applications for the balance of 3,954 shares. Application is also invited at par for issue of 5 per cent. first mortgage debenture bonds for an aggregate amount of £12,500, being half the authorised debenture capital. The company has the option of redemption on and after January 1st, 1896, on giving 6 months' notice.

Chelsea Electricity Supply Company.—The letters of allotment for the 6 per cent. preference shares have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending March 18th, 1894, amounted to £926; week ending March 19th, 1893, £880; increase £46; total receipts for half-year, 1894, £10,400; corresponding period, 1893, £10,412; decrease, £12.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,550.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share.	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, March 14th.	Closing Quotation, March 20th.	Business done during week ended March 20th, 1894. Highest.	Lowest.
184,500£	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	100 —103	100 —103	100½	...
1,134,640£	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	42 — 44	42 — 44	...	...
2,932,680£	Do. do. 6 % Pref.	Stock	£5 5s	£5 10s.	£5 2s.	78½— 79½	77½— 78½	79⅝	77½
2,932,680£	Do. do. Defd.	Stock	...	...	...	6¾— 7¼	7¼— 7⅜	7⅜	7
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11⅝— 12¼	11⅜— 12¼xd	12⅜	12⅛
18,700£	Do. do. 5 % Bonds	100	...	...	...	99 —102	99 —102	...	...
75,000£	Do. do. 5 %, repayable June 1906	100	...	...	...	107 —111	107 —111	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	1½— 2½	1½— 2½	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	145 —150	146 —150 xd	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	... §	1/16 — 3/16	1/16 — 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12 — 13	12 — 13	12⅛	12½
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	18 — 19	18 — 19	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	2 — 3	2½ — 3½	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	...	8 — 9	9½— 9½	8¾	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	...	10⅜— 11	10⅜— 10¾	11	10⅜
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	...	14¾— 15	14¾— 15	15⅛	14⅞
70,000	Do. 6 % Pref.	10	6 % §	6 % §	...	15⅞— 16¼	16 — 16½	16⅜	15⅝
105,900£	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —109	106 —109	...	...
1,294,100£	Do. 4 % Mort. Deb.	Stock	...	...	...	114 —117	113 —116	114½	113½
250,000	Eastern Extension, Australasia and China Teleg., Ltd.	10	7 %	7 %	...	15¼— 15½	15¼—15½	15⅞	15¼
62,700£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —106	104	...
222,800£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	103 —106	...	...
320,000£	Do. 4 % Deb. Stock	Stock	...	...	...	113 —116	112 —115	113	...
95,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —106	103	...
129,100£	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	103 —106	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	103 —106	103 —106	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4⅞% §	4⅝% §	8⅝— 8⅞	8⅝— 8⅞	8⅛	8⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15½ — 15½	15 — 15½	15⅜	15½
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	...	21 — 22	21 — 22	...	...
200,000£	Do. do. do. 5 % Debs.	100	...	...	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	43 — 45	43 — 45	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	4 — 6	4 — 6	...	...
100,000£	Do. do. 6 % Debs.	100	...	...	...	104 —107	105 —108	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	½— 1½	½— 1½	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2	1 — 2	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	...	4½— 4⅝	4½— 4⅝	4⅝	4⅝
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	14½— 15½	14½— 15½	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14 — 15	14 — 15	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5¼— 5½	5¼— 5½	5⅞	...
925,017£	Do. 4½ % Deb. Stock Prov. Certs.	...	...	...	...	113 —115	114 —116	115⅞	115⅛
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
220,000	Oriental Teleph., Ltd., 80,001 to 300,000; 11s. paid	1	2½%	3⅜%	4¼%	⅛— ⅜	... ...xd	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	102 —105	102 —105	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	...	5½— 6½	5½— 6½	...	...
3,381	Submarine Cables Trust	Cert	...	...	...	113 —118	113 —118	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1½— 2	1½— 2	...	...
146,370£	Do. do. 5 % Debs.	Stock	...	...	...	90 —100	90 —100	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	...	3 — 5	3 — 5	...	...
249,900£	Do. do. do. 5 % Debs.	100	...	...	...	98 —101	98 —101	100¼	99
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	2 — 2½	2¼— 2⅜	2⅛	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	97 —101	98 —102	...	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	...	7½— 8	7⅞— 8⅛	7⅞	7½
33,129	Do. do. do. 5 % Cum. Pref.	7½	...	...	...	5⅝— 6¼	6 — 6½	6 5/16	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	1⅞— 2⅛	2 — 2⅛	2¼	2 1/16
178,200£	Do. do. do. 6 % Debs. "A," 1910	100	...	...	...	104 —107	105 —108	...	...
222,700£	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	104 —107	105 —108	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	...	1⅛— 1⅜	1⅛— 1⅜	...	...
34,563	Do. do. do. 6 % 1st Pref.	10	...	...	...	10 — 10½	10 — 10½	10⅜	10 5/16
4,669	Do. do. do. 6 % 2nd Pref.	10	...	...	..	8½— 9½	8½— 9½	...	...
80,000£	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	106 —109	106 —109	...	...
$1,214,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds	$1000	...	...	...	113 —118	113 —118	117⅝	...
169,000£	Do. do. 6 % Ster. Bonds.	100	...	...	...	100 —104	100 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

20,510	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4 — 5	4 — 5	...	...
40,000	Cityof London Elec. Lightg. Co., Ltd., Ord. 40,000—180,000	10	...	...	...	11 — 12	12 — 13	12⅛	11⅜
20,000	Do. do. 6 % Cum. Pref., 1 to 20,000	10	...	6 %	6 %	13 — 13½	13¼— 13⅜	13⅜	13 5/16
19,900	*Electy. Supply Co. of Spain, 101 to 20,000...	5	...	...	...	... ...	... ...	...	...
30,000	†Liverpool Electric Supply, £4 10s. paid	5	...	...	...	5½— 6½	5½— 5⅝	5⅝	5⅜
15,000	Do. do.	5	4½%	5 %	5 %	6⅜— 6⅝	6⅛— 6⅜	6⅞	6¼
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000	10	1 %	2 %	...	8¼— 8¾	8½— 9	8⅝	8⅜
100,000£	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	106 —109	106 — 109	108	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	4½— 5¼	4½— 5½	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	6 — 6½	6¼— 6⅝	6 7/16	6¼
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 8¼	8 — 8½	8 7/16	8⅛
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000	5	...	3½%	4 %	5⅜— 6¼	5⅜— 6¼	...	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, March 14th.	Closing Quotation, March 20th.	Business done during week ended March 20th, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	...	6 % §	6 % §	2⅞— 3	2⅞— 3⅛	2⅞	2⅞
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2½— 2¾	2½— 2⅝	2⅝	2
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	107 —110	108 —111	109½	108¾
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	27 — 32	27 — 32	...	...
20,000	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 20,000	5	7 % §	7 % §	7 % §	3½— 4	3½— 4	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	97 —102	97 —102	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼— ⅜	¼— ⅜	⅜	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1⅛— 2	1⅛— 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd , 1 to 66,750 ..	2	*nil*	*nil*	*nil*	⅛— ¼	⅛— ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	⅛— ¼	⅛— ¼	...	...
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	⅜— ½	⅜— ½	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½— 1⅛	½— 1⅛	...	...
12,134/	Greenwood & Batley, Ltd., Ord., 4,667 to 16,800	10	...	...	...	4½— 5½	4½— 5½	...	...
9,600/	Do. do 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½— 7½	6½— 7½	6⅞	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	23 — 24	23 — 24	23¾	23½
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	103 —105	103 —105	...	...
11,334	International Okonite, Ltd., Ord , 22,667 to 34,000 ...	10	5 % §	...	...	1 — 2	1 — 2	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	6½— 6½	5½— 5½xd	6¼	5
6,295	† Do. do. Pref., £8 paid	10	...	...	...	9½— 9⅝	9 — 9½xd	...	...
78,949	Swan United Electric Light, Ltd., £3½ paid	5	11 % §	10 % §	7½% §	2 — 2½	2 — 2½	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	39 — 41	39 — 41	40	39½
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	... ...	... ...	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—6%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—5⅝.
Brush Company, 4½ % Debenture Stock, issued at 1 % premium, 106—108.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
Electricity Supply Corporation, Ordinary of £5, 5—5¼.
House-to-House Company (£5 paid), 1—1½.
Do. do. 7 % Preference, of £5, 5¼—5½.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅞—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6⅞—6⅞.
Liverpool Electric Supply, £5 (fully paid), 6¼—6¾.
Do. do. £3 10s. paid, 4½—4⅝.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅝.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

On Parallel Working, with Special Reference to Long Lines, by W. M. Mordey, Member. Paper read Thursday, March 8th, 1894.

(*Concluded from page* 322.)

Applying to it a similar comparison, we see that, as the alternators were 2,000-volt 50-kilowatt machines, a line proper to these, in order to comply with the Niagara-Buffalo condition of allowing a loss of 3·5 per cent. in transmission, should have a resistance of

$$\frac{2{,}000 \times 3{\cdot}5}{25 \times 100} = 2{\cdot}8\ \omega;$$

and that the resistance of external circuit that would be sufficient to dispose of the whole load of the generator, supposing it to be merely working on that resistance as a load, would be

$$\frac{2{,}000}{25} = 80\ \omega.$$

Exactly as in the case of the trial witnessed by Professor Forbes, we find that a resistance of about 30 times a reasonable working amount had to be inserted before synchronism was interfered with, and it will be observed that more than 20 ohms had to be inserted before any effect appeared to be produced.

But it may be said that the line loss, even with this enormous resistance, is comparatively trifling, as the current is not large, and that there ought to be plenty of power left to keep the motor in step. There *is* plenty of power, but it cannot be applied to the motor advantageously. The line loss, even with 5·3 ampères and 77 ohms, is only 408 volts and 2,156 watts (I am considering only resistance and current), whereas the generator was capable of supplying 50,000 watts. But it must be remembered that, the E.M.F. of the motor being kept up, it can only receive current under these conditions by letting itself get partly out of phase (and so into a disadvantageous position), and that then every increase of current intensifies the evil by causing a further loss of volts on the line, and therefore a further reduction in the E.M.F. impressed on the motor. Had I lowered the E.M.F. of the motor, or increased the E.M.F. of the generator, the line resistance could have been still further increased without loss of synchronism. Such a change of the relative E.M.Fs. of the motor and of the generator would have allowed currrent to get into the motor against the lower ordinates of its E.M.F. waves, without the necessity for any serious shifting of phase. If the motor E.M.F. had been lowered in this way the driving current would have increased, and synchronism would have been maintained much longer and through a higher line resistance, and would finally have been lost by the power being wasted in the line, and by "armature reaction" on a weakened field.

Or, again, if the excitation of the motor had been raised, it should be found that it would go out of step with a smaller external resistance than before. This matter is of practical importance, as, perhaps, others than Prof. Forbes may wish to work through a line 30 times too long, and therefore some tests were made to prove the truth of this explanation.

Test C.—The machines were run under the conditions of the fifth line of the readings given above—that is, with the excitation as before, and with an external resistance of 63 ohms, the current being 3·5 ampères. The excitation of the motor was then increased, probably about 20 per cent. Before there was time to take any reading the motor went out of step. This was satisfactory as proving the correctness of the explanation.

Test D.—Another test was made with the motor acting as a dynamotor in the manner shown in fig. 2.*

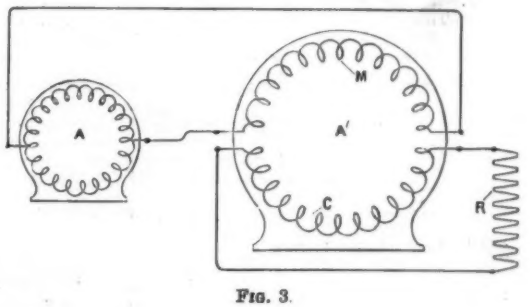


Fig. 3.

One half, M, of the armature winding was used as a motor; the other half, G, as a generator working on a separate circuit, R.

* Also reproduced from last year's paper.

In this instance a load of 5 ampères and 2,000 volts was put on this generator portion, the lowest armature current being obtained with an exciting current of about 11 ampères. The field of this dynamotor was then reduced from 11 to 6 ampères, but it did not show any signs of getting out of step. The driving current rose to 15 or 16 ampères.

But on increasing the dynamotor field to 17 ampères it went out of step, the driving current being about 15 ampères. This test is not on all fours with the other, as there is the effect to be considered of the varying load on G, but it is a confirmation in a general way of the explanation.

Test E.—A test was then made to find, when working with no appreciable resistance between the machines, whether any "hunting," or pulsation was set up by varying the excitation of the motor till the armature current rose considerably up either slope of the "V."

On decreasing the excitation till the armature current rose from 1·6 to 6 ampères the current became rather unsteady or irregular; the motor evidently getting a little out of step sometimes, and being pulled in by slight rushes of current of very short duration, which probably over-corrected the irregularity, causing the machine to run for an instant without current, or to act as a generator and itself to give current—that is, to act as an electro-mechanical fly-wheel, converting mechanical to electrical energy, and *vice versa*.

On increasing the excitation again, passing the bottom of the "V," and rising up the opposite slope to the same height (about 6 ampères), it was found that the current was rather steadier than under the conditions last noted; that is, when the current was about 6 ampères it was rather more unsteady in a strong field than in a weak field.

The explanation of this difference is that with a weak field the motor could receive current during its whole phase; whereas, with a strengthened field the E.M.F. waves would be higher than those of the generator, and some want of co-phasal synchronism would be needed to allow current to get in.

In neither case was there any "hunting" or regular pulsation of current.

Some Tests of a 25-Kilowatt Alternator used as a Motor.

The motor in this case was arranged to drive a direct-current motor by means of which a load could be put on it that would be quite constant so long as speed was constant. It was desired—

(*a*) To find the effect of placing in the alternator circuit various amounts of resistance;

(*b*) To find the effect on the steadiness.

The 25-kilowatt alternator motor was driven by a 50-kilowatt alternator as generator.

Test F.—Motor was run with no load except its own direct-coupled exciter, and the direct-current dynamo, which in this case was run unexcited.

Effect of Reducing Motor Excitation as Resistance in External Circuit was Increased.

A. Generator. Volts.	A. Motor. Volts.	Ampères.	Line resistance.	Remarks.
2,000	2,000	2·23	0	Current varying a little.
1,980	1,900	3·7	0	Current very steady.
2,040	1,900	3·5	65	"
1,960	1,840	2·0	65	"
1,950	1,820	2·23	75	"
1,960	1,800	2·0	85	"
1,960	1,780	2·23	93	"
1,960	1,760	2·23	105	"

We thus see a confirmation of what has been said about steady running being obtained, even with a very large resistance in the circuit, if there is a sufficient difference between volts of generator and motor. This is very common sense, and an experiment to prove it may seems superfluous.

The experiment was not carried further, as the resistance used was the greatest available at the moment. This light load test should be read in connection with the full load test A.

Test G.—A test was then made with a load on the direct-current dynamo. This load was 8 kilowatts, and was constant. Allowing for friction, and various losses outside of itself, the alternator motor was doing between 14 and 15 H.P.

A. Generator. Volts.	A. Motor. Volts.	Ampères.	Power developed, about, H.P.	Resistance.	Remarks.
2,040	2,040	7·0	14·5	0	Current fairly steady.
2,040	1,980	7·3	"	6	"
2,060	2,000	7·45	"	10	"
2,010	1,900	8·2	"	25	Current steadier.
2,040	1,740	9·8	"	35	Current steady.
2,120	1,510	11·0	"	45	"

In this is seen the gradual increase of motor current as the motor volts get lower, while steadiness rather improves with the addition of length (or resistance) of line. The test is incomplete, because it was not convenient to put a larger load on, and therefore the motor was not worked up to full power; but it is confirmatory of Test A. It is interesting to observe, with regard to this test, that the idle current was very small. For example, the first reading of 7 ampères may be divided into 2·25 ampères needed to drive the motor and its exciter, and for friction of the direct current dynamo (see Test F); and into 4·75 ampères for the added load of 8 kilowatts. The dynamo gave 8 kilowatts, and the motor received about 4·75 ampères × 2,040 volts = 9,690 watts. Allowing for the losses in the two machines, it will be recognised that the transformation was not only very fairly efficient, but that the power-factor was evidently high.

The relative lowering of the E.M.F. of a synchronous motor is a necessity in order to obtain good results in power transmission over long distances. In this way the necessity for self-adjustment by the motor of the phase relation is avoided, the motor being enabled to work (other qualities permitting) at its most advantageous phase relation. And the other advantages are retained of high power-factor (that is, a small idle current), and a high efficiency of generator, motor and line. By this means it will be found possible to work such motors over very long lines, and with almost any desired line loss. It of course has its counterpart in direct-current power transmission, but there is a difference. In one case the speed varies and the field remains constant; in the other the speed remains constant and the field must be varied. It is not necessary to alter the excitation of a direct-current motor—its speed simply drops or rises until it has got the right E.M.F. With an alternate current synchronous motor the speed cannot drop. The excitation must be lowered in this case to give the right E.M.F. Failing this, the motor will shift its phase in an endeavour to attain the same result. Of course in the direct-current machine the speed may be kept up by lowering the field.

Some Tests of Two 100-Kilowatt Alternators.

Test H.—By the kindness of the City of London Company, I was enabled to make a trial with two of their 100-kilowatt alternators at Bankside, with the object of finding if, under the ordinary conditions of the station, these machines would work parallel with a considerable resistance between them and their load.

For this purpose a load of about 100 kilowatts was put on, and the two alternators were made to supply it through a resistance of 7·5 ohms in the external circuit of each. As this resistance corresponds to 37·5 per cent. line drop at full load, and 18·75 per cent. drop at half load, it is a fairly severe test. It was found that some lamps and a voltmeter placed across the load (a wire resistance) kept perfectly steady.

This, of course, was only a half-load test.

Test J.—When full load, or nearly full load, was on both machines, with 8 ohms in the circuit of each, there was a quite noticeable, but not at all violent, slow pulsation in the synchroniser lamp direct across the terminals of the alternators; but at the load the pulsation was very slight—barely noticeable. My impression was that with suitable adjustments this would have been quite a practicable arrangement—that is, to feed a lighting system from two alternators parallel, each having a 20 per cent. line loss between it and the load—a condition that is not likely to present itself very often.

Test K.—An attempt was then made to run the two machines parallel, with a load close to one of them, but separated from the other by a line of 16 ohms, corresponding to a line loss of about 40 per cent. The machines did not show any inclination to get out of step, but there was a pulsation of the E.M.F. at the lamps (at the load) of about 4 or 5 per cent. The result of this test, as carried out, was not good enough for lighting; although, if time and facilities had allowed, I think it quite likely that it could have been made satisfactory; but there was no pulsation or unsteadiness of a kind that would have interfered in any way with power transmission work.

It is a pleasure to me to make my acknowledgments to two assistants, Mr. Stobart and Mr. Fuyster, who have ably aided me in connection with the recent tests and experiments, and to Mr. Watson in connection with the tests in 1891.

Some Analogies.

Probably I am not alone in having often found a difficulty in conveying, to persons not specially familiar with alternate current matters, any very clear idea of the kind of action that takes place in parallel working. I would like, therefore, to be allowed to conclude by describing an analogy which I have often found useful in such cases.

Everybody knows something of toothed wheels.

To explain the relations of two alternators, separately driven, working parallel, imagine two engines driving by spur gearing on to a common shaft. The shaft represents the circuit from which power may be taken; the spurs, or teeth, represent the successive waves of current.

The operation of getting into synchronism is understood when one engine is imagined as running at its proper speed geared with the countershaft. To get the second engine to help, it will readily be understood that before being geared with the shaft it must be brought up to such a speed that the spurs of its toothed wheel synchronise with those on the shaft. A synchroniser, or phase-indicator, is the equivalent of a device for showing when the teeth of one wheel are exactly opposite the spaces between the teeth of the other wheel—that is, when they are synchronous. The mechanical process of slipping the two spur wheels together is the equivalent of electrically connecting the alternator and the circuit, and all the effects of doing this switching at the wrong time are easily illustrated by the sudden strain that would be imposed on the teeth. It will now be easy to follow the process of increasing the supply of steam to the engine until it transmits its proper proportion of power to the shaft; as well as the reduction of steam to such a point that the connection of either engine with the shaft (or of

alternator with the circuit) can be interrupted at a time when no power is being transmitted from it or to it, and when, in consequence, its withdrawal makes no difference to the remaining engine (or alternator) or to the countershaft (or circuit). The changing of load from one engine to the other is readily understood.

Then the difficulties of parallel running may be made clear. Imagine one engine to get an insufficient supply of steam: it will be seen how the other must not only keep the countershaft (and any load) going, but must also drive the other engine. And note that this driven engine (receiving its power from the countershaft) is the analogue of the synchronous motor, and that the fact that the pressure is now not on the front side, but on the rear side, of the teeth, corresponds to the pull on the poles and armature coils being in the opposite direction to what it was as a generator; and that the difference of phase, or angle, between a generator and a motor is illustrated by this change in the relative position of the teeth on spur wheel and shaft. If the teeth of one wheel are exactly midway between those of the other, corresponding to exact cophasal synchronism, a line drawn through the tip of one bisects the hollow of the other; and driving is possible either way, in this position, only if there is absolute fit—that is no lag or lead—no clearance either side. As this is not possible in practice, there is always a lead or a lag, corresponding to similar changes in the relative positions of field and armature in an alternator, as generator and as motor; this change of angle being also conveniently expressed or measured in terms of the space occupied by a pair of teeth or a complete period.

Then it is possible, by this analogy, to get an engine builder to see what happens when an engine runs at different speeds during parts of each revolution. He will see that, if two engines are in use, and one is slowing a little as it goes over its dead centres, while the other is getting steam and quickening a little, the teeth of the former will be bearing with diminished pressure on the teeth of the countershaft, while the latter will be exerting increased pressure. And he will see that, if this difference is considerable, the power may all have to be supplied by one engine, which may even have to drive the other engine as well—that, in short, each engine may in each revolution be alternately a generator and a motor, twice or oftener (according to the number and setting of the cranks).

It will not be difficult to explain the pulsations of synchronising current transmitted through the circuit between the two alternators by the analogy of the impulses transmitted from one engine to another through the countershaft.

He will also understand why, if the engines have this defect, this interchange of power will take place, and will not be required, if he so arranges matters that the connection is made at a time when the engines (supposing them arranged to run at the same speed) are in the same part of their stroke; but in this case, as the engines cannot correct each other's irregularities, the speed of the countershaft may have an objectionable want of evenness of running, affecting any machinery driven from the countershaft—that this difference will be less on the driven machinery if it is driven by belting, and therefore not necessarily synchronous, than if it is driven by spur gearing, and so forced to run at the same speed.

I will not stop to do more than suggest the comparisons that may usefully be drawn between weight of fly-wheel and of electro-magnetic inertia or self-induction as illustrating the effects in steadying the running of all shafts or circuits. But I cannot resist the temptation to show that, as with alternators in parallel the very rapid interchanges of power take place with scarcely perceptible resistance (that is, frictional) losses, it is conceivable that two such machines and engines will take less steam to drive them than if they are dividing the same load between them on separate circuits. That this increase in efficiency is a fact has been shown by actual tests, which I hope later on will be placed before you.

Then the analogy may be carried further, and an understanding may be imparted of the difference in the synchronising abilities of various alternators. To do this it is necessary to add to the analogy of spur gearing the idea of that gearing having teeth of various degrees of stiffness or rigidity, varying all the way from phosphor-bronze to yielding elastic material such as soft rubber. The former may be compared to the alternators having unyielding fields and small armature reaction; the latter to machines having poles the magnetism of which gives way, more or less, under pressure.

It will, no doubt, be difficult to get the uninitiated to grasp the idea of a tuft of lines of magnetic force from a pole-piece acting, through air, on a copper wire carrying a current, as corresponding to the material teeth of spur wheels geared together; but it is at least worth the attempt, and the result is usually better than the antecedent chaos.

Having conveyed this idea of various degrees of rigidity of teeth, as the equivalent of the various degrees of synchronising efforts of which different alternators are capable, the next step is to explain why with alternators having magnetic teeth of the gelatinous variety it is possible to put them into parallel (or to gear them) when they are unsynchronous, without anything happening except a more or less complete temporary flattening of the teeth (or alternations) of both machines, corresponding to a temporary cessation of useful effort, until they have gradually worked themselves into phase. And it will be understood why with such machines any sudden alterations or strains should be avoided as likely to result in the bending down of the teeth, and loss of synchronism. On the other hand, it will be seen that, if the machines have strong and unyielding teeth (or powerful synchronising qualities), they will make a prodigious effort to keep in step whatever happens.

This analogy affords an explanation of the difference in the way in which the synchronising current circulates between alternators of the two kinds. With spur wheels of the strong type it will be seen that any transfer of power will be immediate and prompt, the correcting impulses being transmitted with decision and sharpness, the lagging or yielding permitted being only that due to the space between the teeth. This corresponds with the short, sharp impulses of synchronising current between two alternators of one type; while the slow and sluggish impulses of current between two alternators of the weak field type is understood by imagining what would happen with an attempted interchange of power between the two engines geared to a shaft by teeth of some yielding material.

A further analogy and I have done, to show those who are at all familiar with the mechanics of spur gearing how unnecessary it ought to be, so far as the machines are concerned, to reduce the number of magnetic teeth, or periods, in order to get satisfactory and smooth driving, either singly or parallel. It is only in cases where the electrical spur wheels are so designed that the teeth cannot get in, that a small number of periods can be of any service (so far as the machinery is concerned.) Steady and smooth driving is rather to be sought in the other direction.

VARIOUS SYSTEMS OF UNDERGROUND MAINS AND METHODS OF LAYING SAME.*

By S. V. CLIREHUGH, Assoc.M.Inst.C.E.

I am sure that any central station engineer will bear me out in saying that the mains are one of the most important points of a central station, and on them depends, to a very large extent, the satisfactory working of the station.

Everything else from boilers to dynamos is duplicated, but mains it is practically impossible to duplicate. There is no stand by, hence the importance of selecting a system with the utmost care.

Let us consider what are the first things to be aimed at in any system of mains.

1. Cheapness.—This is always an important point to consider, as it is generally the non-technical public who find the money, and it is difficult to convince them that very often cheapness in this particular line is very false economy.

2. Long Life.—Very little actual experience is available as to the probable duration of any form of insulating material at present in use.

3. Facility for increasing the sectional area of copper without disturbing the surface of the ground.

4. Facility for fault finding, repairing, inspection, jointing, &c.

Having detailed the various points which are considered desirable in a system of underground mains, we may now consider to what extent we can combine them in any one system, and what are the various materials at our disposal.

There are, broadly speaking, three systems to be considered.

1. Insulated Cables in Conduits.
2. Armoured Cables.
3. Bare Copper in Culverts.

One of the oldest systems which was practised on anything like a large scale was that laying C.I. pipes 3 to 4 inches in diameter, into which were drawn insulated cables; boxes being built at first about every 80 yards, merely for the purpose of drawing in the cables and making straight joints.

This plan is, in my opinion, very suitable for a district in which it is difficult to ascertain the probable demand which is served with a high tension alternating current system.

The *modus operandi* being as follows:—A cable having a conductor of small sectional area, say, 7/16 S.W.G., is drawn into the pipe, and the first consumers are supplied therefrom, transformers being fixed on each consumer's premises. When the demand becomes sufficiently great, that is to say when there are, say, 12 consumers within 100 yards, the high tension services are then cut off in the boxes which are built as occasion arises. A transformer station is then built, and a low tension main is drawn into the pipe. The H.T. feeder being left in is available for feeding this and more distant points. If it is likely to be necessary to draw in many separate cables, it is advisable to lay two pipes, as several cables laying in one pipe have a curious way of twisting themselves together, thus rendering it difficult to pull out any particular cable.

We now come to the question of the insulating material, which we are going to draw into the pipes. Insulated cables may at once be divided into two classes.

One in which the dielectric is unaffected by the presence of moisture, the other in which the dielectric must be protected from moisture of all kinds by being hermetically sealed in a metallic envelope. The materials used to insulate the first class of cables are India-rubber, gutta-percha, and bittite, and for cables of the second class, jute, hemp, cotton and paper, impregnated with oil, wax, or bituminous or resinous compounds.

We will now consider cables of the first class. In connection with these, the only insulating materials, as far as the author is aware, worthy of consideration, are India-rubber, bittite; okonite, as far as the author knows, never having been made commercially in this country.

Gutta-percha, although probably the first insulating material used, is now used solely for telegraph and telephone purposes, and that now to a limited extent, except in the case of submarine cables, where it still holds its own.

The great objection to the use of gutta-percha, except for submarine telegraph work, is, that it softens at a very low temperature, and

* Paper read before the Northern Society of Electrical Engineers, Manchester, March 12th, 1894.

when exposed to the light and air becomes brittle, and cracks, sometimes, even crumbling away into powder.

Cables insulated with vulcanised India-rubber stand, no doubt, from a scientific point of view, at the top. We have now had considerable experience in the question of the life of India-rubber, as an insulator I hardly know how many years, but I am sure Mr. G. Preece will be able to give us further data. I myself remember taking out some India-rubber cables which were laid in London for the London Electric Supply Corporation, and which had been in constant service many years, which showed not the slightest signs of deterioration, and I may mention that the only reason they were removed was to enable them to be made concentric; they were replaced, and are working to this day.

I should like to say a few words on the question of vulcanising India-rubber. As you are all probably aware, vulcanising has only been known about 30 years. I again must appeal to Mr. G. Preece. Prior to that time cables were insulated with pure rubber strip lapped spirally round the conductor, the overlapping parts of the strip being made to stick together by the use of naphtha, which is a solvent of India-rubber. This, of course, was most unsatisfactory, and caused the rubber to decompose very rapidly. I often wonder what will become of the mass of joints in house wiring in 20 years time.

Vulcanising, of course, went through various stages, with which I need not trouble you, before it reached its present one.

The process is, in itself, very simple, but requires long practice and considerable skill before it can be satisfactorily carried out. It is as follows:—A small quantity of sulphur is mixed with the rubber, and the mixture is subjected to a temperature of about 250° to 300° F. whilst keeping it under pressure. The difficulties presented by the process are the different times required by the different classes of rubber, varying from one to four hours for the cure and the amount of sulphur to be used.

By vulcanisation the sulphur combines chemically with the rubber, with the result that the decomposing agent is neutralised.

In some places the difficulty offered by being unable to keep a vulcaniser is serious, as the men are highly paid, and on a small station there is not, of course, sufficient to keep even one fully occupied. In such cases it is sometimes necessary to use mechanical jointers, *i.e.*, C.I. boxes, which are placed over the joint, bolted together, and filled with a bituminous compound. This makes a thoroughly good job, but it is very difficult to break the joint should it for any reason become necessary. Another plan is to insulate the joints with pure rubber strip, and when there are sufficient number of them, say 20 to 30, ready to be cured, get the cable manufacturer to send a vulcaniser down for a week or so.

Vulcanising, it will be seen, is a very delicate operation, the success of the joint being entirely dependent on the care taken by the jointer, and too much importance cannot be laid on the point of cleanliness.

A rough test as to whether a joint is properly cured is to try and mark the rubber when cool with the thumb nail; if it is just right it will yield to the thumb nail but leave no mark; if it leaves a mark it is undercured, and if it feels hard it is probably overcured.

The only objections, therefore, to the use of cables insulated with India-rubber are practically its high price and the difficulties in jointing. I would specially warn engineers to be very chary of purchasing low-priced rubber cables, as it is almost impossible for anybody not an expert to tell whether the rubber is good or bad quality. Low prices in rubber cables generally means that a large amount of compound has taken the place of rubber.

We now come to the only other practical insulating material, viz., bittite, of which I regret to say I have had very little experience.

Bittite, which is the material used by the Callender Company, is believed to be bitumen refined to purity and vulcanised. The conductor is covered with a solid sheath of this material, put on in one operation under pressure, and is served with a tape and covered with an insulating compound and again taped, then braided with a hemp yarn and passed through a bath of hot asphalte compound.

Joints in the cables are insulated by wrapping the conductor with bittite which has been half vulcanised, up to the diameter of the original insulation, and then protecting it by a wrapping of compounded tapes. The joint is then heated by means of a lamp, to make the wrappings solid, and to complete vulcanisation. This system of jointing is very simple, and no particular training is required for the purpose.

The Callender Company had at one time, I believe, difficulties which they have now got over, owing to the tendency of the conductor to decentralise, and I have also heard that the insulation sometimes stuck to the culvert, rendering it difficult to remove. However, my experience with them is not of recent date, and as I see a representative of the Callender Company here, he will no doubt be able to correct any errors into which I have fallen. Callender cables are used very largely, and I believe with great success in this country for L.T., but up to the present not much for H.T.

You will see on the wall a table giving approximately the cost of a yard of main on the three-wire system, low tension of the various classes of cables, &c., and also for concentric cables for H.T. systems; the item for excavating and making good, of course, varies enormously, both according to the town, and the nature of the ground.

We now turn to cables of the second class, *i.e.*, the insulation of which is not in itself damp resisting, but which has to be protected by a metallic envelope, and on this I feel some difficulty in expressing myself, lest I should appear prejudiced, as I was for two years engineer to the British Insulated Wire Company, whose speciality is fibrous insulation, applied in the form of paper. In describing one lead-covered fibrous cable, you have described them all, as they all have the same faults and the same advantages, apart from the question of excellence of manufacture, into which it would be invidious to enter.

I have said above that India-rubber, as an insulator, stands scientifically at the top, which is no doubt true; but it is expensive, and if you can get an article which will answer the purpose equally well at a lower price, it is certainly advisable to use it. The question now presents itself as to whether a fibrous cable will answer equally well, and I say decidedly yes, if you are prepared to treat it with sufficient care. Very frequently, however, fibrous cables get into the hands of jointers who have been given no special instructions, and they treat it as they have been accustomed to treat a cable insulated with India-rubber, with, of course, unsuccessful results.

Approximate cost of laying a yard of Main on the Three-Wire System. The Outer Conductors having a sectional area of 4 *square inches. The Middle Conductor* 2 *square inches.*

System.	Cost of conduit.	Cost of conductor.	Excavating and making good, including laying jointing conductors.	Total.
4 square inch C.I. pipes, with India-rubber insulated cables drawn in.	£0 2 0	£1 3 0	5s., including boxes at the rate of 12 per mile.	£1 10 0
4 square inch C.I. pipes, with fibrous lead covered cables.	£0 2 0	£0 18 0	5s., including boxes at the rate of 12 per mile.	£1 5 0
	Cost of culvert complete, including making good.			
Bare Copper Strip.	£0 17 0	£0 18 0	Nil.	£1 7 0
Callender between three-way casing may be used at about the same cost as C.I. pipes.	—	—	—	—

Cost of laying a Concentric Cable suitable for a pressure of 2,000 *volts, each Conductor having a sectional area of* 155 *square inches.*

	Cost of pipe.	Conductor.	Excavations.	Total.
3 inch C.I. pipe, into which India-rubber insulated cables all drawn	£0 1 8	£0 11 6	£0 5 0	£0 18 2
3 inch C.I. pipe, into which lead covered cables all drawn	£0 1 8	£0 8 0	£0 5 0	£0 14 8
3 inch C.I. pipe, into which armoured cables all drawn.	Nil.	£0 9 0	£0 4 9	£0 13 9

Fibrous cables are not so flexible as those insulated with India-rubber, but for nearly all practical purposes are quite flexible enough.

The manufacture of lead-covered fibrous cables is fairly well known. I will not detain you long in describing it, merely saying that the fibrous material, be it in the form of yarn or paper, is laid spirally round the cable, pressure being applied to solidify the mass as much as possible to the required thickness; the cable is then thoroughly dried out at a temperature of about 250° F. for 30 to 40 hours to expel every possible trace of moisture, and it is then immersed in wax, resinous oils, or similar materials at a high temperature.

From this tank without any further contact with the air, it is passed through a lead press, and so hermetically sealed.

The great danger in these cables to guard against is the possibility of the formation of "pinholes" during the process of lead covering. These are produced by a variety of causes, but probably the most troublesome one is produced by impurities in the lead. These "pinholes" are very difficult to perceive during manufacture, but they are generally found by testing after prolonged immersion under water. It is very important in buying this class of cable to find out what insulation resistance the manufacturer recommends, and to see that all cables of the same class have approximately the same insulation resistance after one minute's electrification and 24 hours' immersion in water. The electrification being very marked in this form of cable, it is essential to see that this limit is adhered to.

One word about the insulation resistance of these cables. I have found by experience that it is better not to insist upon too high an insulation resistance, but to insist on its being uniform. Cable manufacturers are a good deal bothered by having high insulation resistance specified. It can be produced if desired, but I believe at the expense of the life of the cable caused by excessive drying out. The pressure test is a very useful one, and cables of this class should certainly be tested after immersion with at least double the pressure at which they are intended to work. The cables should again be tested for insulation resistance, and the result should be the same as before the pressure was applied.

We now come to the treatment of the cables after they are delivered in the streets, and we will assume they are to be drawn into cast-iron pipes. Cables which are to be thus treated should be either taped or braided outside the lead, preferably the latter to prevent any roughness in the pipe scoring the cable. If the cable is a heavy one, some lubrication is often desirable, and for this purpose there is nothing better than soft soap. In a straight run with a moderate sized cable 80—100 yards may be drawn in in one length, great care

being taken to avoid kinks or sharp bends. It will be noticed that the end of the cable is sealed up, and when this end is cut it must be re-sealed as soon as possible, as the insulation being very hygroscopic, the insulation resistance of the cable is quickly lowered if the end remain exposed too long to the atmosphere.

A good temporary way of sealing the end of a cable is to lap it with dry cotton tape and plunge it into hot pitch.

As regards jointing of these cables, you will see on the table samples of joints in various stages of manufacture, which will illustrate the subject better than anything I can say. The only skilled labour necessary in making these joints is for wiping the joints, and an ordinary plumber will in the course of a few hours be thoroughly competent. Two holes are left in the lead sleeve, on to one of which a tube of about 12 inches long is soldered, and resinous oil is poured down the tube, the length of the column of oil causing sufficient pressure to enable the oil to thoroughly permeate the insulation of the joint. A straight joint in a concentric cable, say 7/16 S.W.G., should be completed in about one hour.

When it is required to end a cable for any purpose a lead cup is soldered round the sheathing and filled with paraffin wax. The difficulties in connection with this class of cable are thus, it will be seen, largely overrated, and with due care it will serve every purpose that is served by rubber-insulated cables; the jointing being, to my mind, considerably easier. As regards the life of these cables, we are again without any actual experience to guide us, but I see no reason, as long as the lead covering remains intact, that any depreciation should take place. Through the courtesy of the Fowler-Waring Company, and the British Insulated Wire Company, I am able to show you various samples of their manufacture.

(To be continued.)

TELEGRAPHISTS' SCHOOL OF SCIENCE.

This school was started in the Central Telegraph Office in 1876, with the object of imparting to telegraphists a scientific knowledge of the apparatus and lines which they were in the habit of working. The success of the school is evidenced by the fact that in many of the large towns the experiment has been imitated, although with varying degrees of success. The students met for their seventeenth annual prize distribution in the Postmaster-General's deputation-room, on Tuesday afternoon. The chair was taken by Mr. H. C. Fischer, Controller of the Central Telegraph Office, who was supported by Mr. J. C. Lamb, C.M.G., the Secretary for the Telegraph Department, Mr. J. Ardron, Mr. T. Barlow, President of the School, Mr. J. T. Hill, Mr. Jelf, Mr. A. E. Eames, Mr. Maclachlan, and Mr. H. Mayfield, the secretary of the school.

The business commenced by the reading of the following report:—

The number of students registered during the session was 150, as against 120 in the preceding session. During the month of May the students were examined in the various subjects by the Science and Art Department and the City and Guilds of London Technical Institute.

In the electricity examination, 48 candidates presented themselves in the elementary stage, and of these 21 were successful, the percentage success being therefore 44, whilst the average success of other schools in the kingdom was only 24 per cent. In the advanced stage there were 12 candidates, of whom 3 passed first class and 6 second class, there being but 3 failures. Of the students sent up by other schools only 58 per cent. passed.

In mathematics, 12 passed in the elementary stage out of a total of 24, the proportional success for other schools being only 29 per cent. In the advanced stage, one took first class and four took second class certificates, there being no failures; about 50 per cent. of the students from other schools failed. In mechanical drawing, one passed in honours, two in the advanced stage, and one in the elementary stage. There were two failures.

In the telegraphy examination the students of this school obtained as many certificates as all the other schools in the kingdom put together. This examination is divided into two grades, ordinary and honours. In the honours grade the first prize in the United Kingdom, consisting of a silver medal and £3, was obtained by Mr. A. R. Nichols. In this stage 10 first class and three second class certificates were also gained. In the ordinary grade the first prize in the United Kingdom, consisting of a silver medal and £2, was gained by Mr. G. R. Adams, and the third prize, consisting of a bronze medal and £1, was gained by Mr. C. G. Roach. It will thus be seen that the school obtained both the silver and one of the three bronze medals offered in competition. 13 first class and 22 second class certificates were also obtained in the ordinary grades.

Three candidates presented themselves for examination in electric lighting; two of them passed first class, and one second class.

The number of certificates taken shows an advance of 50 per cent. over the preceding year. 114 local prizes were awarded, the chief being four grand aggregate prizes, which were awarded to those students who exhibited the greatest progress during the year in all branches of the school work. The first was allotted to Mr. C. W. Wheeler, the second to Mr. E. W. J. Todd, the third to Mr. G. Laslett, and the fourth to Mr. R. W. Callender.

The Chairman, in moving the adoption of this report, commented very favourably upon the success of the year's work, and highly complimented Mr. Slingo (the principal) and his very efficient staff upon their labours, which he said contributed materially to the expeditious and economical disposal of the traffic. The result of the scientific training was, that the cost of supervision was sensibly lessened. He further said that during his recent visits to the large provincial towns he had strongly recommended the introduction of a system of training similar to that in vogue at this school, but he, and others who were with him, were strongly impressed with the apparent absence of any effort upon the part of the female members of the staff to obtain any technical education, and he was rather anxious to know whether this was due to a want of opportunity or of inclination. He further mentioned that when the Engineer-in-Chief asked for nominations from the commercial to the technical staff, he made it a practice to look first among the members of the school.

Mr. Maclachlan, in seconding the adoption of the report, gave personal testimony to the practical utility of the school, and mentioned, as an instance, that in cases of serious breakdown, when the ordinary technical staff is naturally inadequate to cope with the increased work, every difficulty is promptly overcome by calling upon the more prominent students of the school. Similarly, when new and complicated apparatus is introduced into the office, there is no need to specially train the staff, as the students immediately make themselves acquainted with all the necessary details.

Mr. Lamb, previously to distributing the prizes and certificates, briefly addressed the meeting on the subject of "Books." He strongly advised the students to be very cautious in the selection of their books, and, having obtained them, to treat them as friends whose companionship would banish all sense of solitude, and to which we might always turn either for recreation or consolation, without ceremony or introduction. The address was exceedingly interesting, and highly applauded.

The interest which Mr. Lamb, and the officers of the Department generally, take in the school was testified by Mr. Barlow, in proposing a vote of thanks to Mr. Lamb for distributing the prizes, the proposition being carried with great acclamation.

Mr. Slingo, in proposing a vote of thanks to the Department for the facilities offered and for the assistance afforded to the school by the Department, remarked that 700 members of the staff had already passed through the school, and that the benefit of the training which those telegraphists had received, extended even to those who had had no such training, for the untrained clerks were always ready to pick up by "rule of thumb" the methods of adjustment as carried out by the students in their daily work.

It was also pointed out, as an interesting fact, that the best and most prominent men in the Central Telegraph Office had passed through the school.

The interest in the proceedings was maintained throughout the ceremony, and on the motion of Mr. Ardron, a very cordial vote of thanks to the chairman was passed.

NEW PATENTS—1894.

4,572. "Improvements in telephonic transmitters." C. Adams-Randall. Dated March 5th.

4,575. "Improvements in connection with electrical tramways." E. E. Vaughton. Dated March 5th.

4,610. "An improved temperature regulating device for electricity meters." E. F. Moy. Dated March 5th.

4,635. "Improvements in galvanic batteries." H. Wehmann. Dated March 5th.

4,647. "Improvements in electric lighting by incandescence lamps arranged in series." T. R. Burrell and F. Fowkes. Dated March 6th.

4,691. "Improvements in apparatus for connecting and disconnecting electrical circuits." A. P. Lundberg, G. C. Lundberg, and G. Pegg. Dated March 6th.

4,724. "Improvements in and relating to secondary batteries." O. March. Dated March 6th.

4,788. "Improvements in standard resistance boxes." F. H. Nalder, H. Nalder, C. W. S. Crawley, and A. Soames. Dated March 7th.

4,805. "A new or improved method of lighting cycle lamps by means of electricity." J. M. Klingelsmith. Dated March 7th.

4,828. "A combined tachometer and telemeter." E. Butikofer. Dated March 7th.

4,849. "Improvements in casings, culverts, or means for supporting and protecting electrical conductors." G. St. J. Day and S. Allmark. Dated March 8th.

4,904. "Improvements relating to electric lamps." R. Hacking, G. Brand, A. G. Howitt, and J. Johnstone. Dated March 8th.

4,909. "Improvements in or relating to combined targets and electrical indicating apparatus." G. H. Collins and C. S. Jones. Dated March 8th. *(Complete.)*

4,910. "Improvements in or relating to the distribution and utilisation of electricity." W. L. Wise. (Communicated by E Modesse, Belgium.) Dated March 8th.

4,911. "Improvements in or relating to electric supply apparatus such as alternators and transformers, applicable also to other purposes." W. M. Mordey. Dated March 8th.

4,945. "A combined electricity meter and automatic switch with apparatus for registering the position of an index or pointer." E. G. Pink. Dated March 9th.

4,969. "Improved device for converting and making oil lamps suitable for electric light." S. F. Gough-Calthorpe. Dated March 9th.

4,987. "An improvement in arc electric lamps." E. C. de Segundo. Dated March 9th. *(Complete.)*

4,993. "An improvement or improvements in joints for suspending electroliers." W. Whitehouse and H. Pinkell. Dated March 9th.

5,001. "Improvements in connection with electric fuses and switches." A. Essinger and T. Harden. Dated March 9th.

5,002. "Electric lamps." H. G. Nichols. Dated March 9th.

5,003. "Improvements in regulating electric motors." J. G. W. Aldridge. Dated March 9th.

5,014. "Using oil engines, gas engines, and electric engines or motors for working of capstans on fishing or other boats and cranes, &c." W. S. Richmond. Dated March 10th.

5,025. "Improvements in electric rail or tramway systems." M. H. Smith. Dated March 10th. (*Complete.*)

5,026. "Improvements connected with the apparatus for raising and lowering the centre lights of chandeliers and electroliers, also applicable to brackets and like fittings." R. H. Best. Dated March 10th.

5,072. "Improvements in hangers for trolley wires." G. H. Ricke. Dated March 10th.

5,089. "Improvements in oil engines." J. Roots. Dated March 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

5,694. "Improvements in apparatus for the electrolytic decomposition of solutions of chloride of sodium and potassium." J. C. Richardson. Dated March 16th. Claim:—Apparatus for use in the electrolytic decomposition of chloride of sodium and other solutions, consisting of a tank with a covered anode compartment or compartments, and below the same, an inverted trough or troughs backed with insulating material, containing the negative electrode, and extending beyond the anode chamber, substantially as described and shown.

6,241. "Improvements in electricity meters or motive devices for measuring single and multiphase electric currents." T. Duncan. Dated March 23rd. The principal elements employed in the construction of the improved electric meter or motor device, are:—1. An armature of metal capable of rotation; 2. An electric circuit or circuits, so arranged that when traversed by simple alternating or polyphase currents, a field of force is induced, having a given polar line or axis with reference to said armature; 3. An adjustable magnetic path diverter of iron or other magnetisable metal, so arranged with reference to said field of force that secondary currents are induced in the armature in such a plane that the repulsion between them and the inducing field will produce rotation of the armature. 11 claims.

6,517. "Improved means for producing and applying induced electric currents for heating and other purposes." S. B. Jenkins. Dated March 28th. The primary object of this invention is to utilise for practical purposes the reversed induced current which is set up in a conductor when the primary current is interrupted; the said conductor being wound on a magnetic and a second conductor being wound on the same core reversely with respect to its length for the passage of a second current of electricity continuously in an opposite direction from end to end of the core in order to prevent sparking when the circuit of the first current is thus broken. 3 claims.

11,069. "Improvements in or relating to producing (or maintaining) continuous lines of telegraph wires, rails, pipes, and other metallic line structures, and in apparatus or devices connected therewith." W. P. Thompson. (A communication by E. E. Ries and A. H. Henderson, both of America.) Dated June 6th. The present invention is designed to admit of the easy and comfortable transportation of welding and other metal working apparatus, but more especially the former, from place to place along a line structure. 13 claims.

11,077. "Automatic circuit breaking safety apparatus for electric railway and other electric circuits." C. Peterson. Dated June 6th. The object of the invention is to reduce the danger of accidents from the communication of the current from the broken ends of the wire when a fracture occurs. 5 claims.

11,105. "Improvements in electrolytic apparatus." T. Craney. Dated June 6th. Consists in the peculiar construction of an electrolytic cell, and in the combination and arrangement of a series of said cells in an apparatus, whereby the process of decomposition is carried out in an accumulative manner, so as to obtain the electrolyte in a concentrated solution. 2 claims.

11,107. "Improvements in electrolytic apparatus." T. Craney. Dated June 6th. Consists more specifically in the peculiar construction and arrangement of the electrolytic vessel, whereby the same is provided in a simple and economical manner with an efficient diaphragm, effecting, in connection with the peculiar shape of the vessel, a complete separation of the products of electrolysis, and at the same time facilitating their ultimate separation and collection. 2 claims.

11,143. "Improvements in electrical switches, fuses, ceiling plates, wall connectors, and the like." C. M. Dorman and R. A. Smith. Dated June 7th. The object of the invention is to enable the fittings to be made without any metallic parts projecting through at the back of the insulating base, and also, at the same time, without any screw threads tapped into the front of the insulating base. 2 claims.

11,579. "A new or improved method of and apparatus for electrically heating or welding metal." W. P. Thompson. (A communication by C. L. Coffin, of America.) Dated June 13th. Consists in a method of and apparatus for electrically welding sheet metal, pipes, tubes, rings, tires, or continuous metal articles. 4 claims.

11,608. "Improvements in electrical heaters." J. F. McElroy. Dated June 13th. Claims:—1. In an electric heater, a wire wound in the form of a spiral spring extending in a spiral path about a cylindrically formed non-conductor, in such a manner that each spiral shall come into contact with the non-conductor at one point only, and the layers of spirals shall be separated from each other, substantially as described and for the purpose set forth. 2. In an electric heater, the combination of an insulating substance, a wire coiled in the form of a spiral spring extending in a spiral path about said insulating substance, a non-conducting material placed between the adjacent layers of the said spring, substantially as described and for the purpose set forth.

11,622. "Process of magnetic separation and apparatus adapted to the conduct of such process." R. H. Sanders and C. T. Thompson. Dated June 13th. Claims:—1. The described process of magnetic separation, which consists in feeding stock to the upper portion of an overhanging surface of substantially single polarity, whereby the ore is detained and gangue permitted to drop off; causing the ore to descend along said surface by new accretions fed at the upper portion thereof, permitting the remaining gangue to drop out during the period of descent, and finally causing the discharge of the cleaned ore by surcharging the polar surface, substantially as set forth. 2. The combination of a magnet having an overhanging elongated polarised surface; a shield arranged along each side of the said surface; a feeding device arranged to deliver stock to the upper end of the said surface, and separate receptacles for gangue and ore, subjacent respectively to the upper and lower ends of said surface, substantially as set forth.

11,680. "Improvements in electric alarm apparatus, applicable for doors, windows, safes, and the like." F. Sauer and C. Hentzschel. Dated June 14th. The apparatus, when applied to a door, is fixed to that jamb on which the striking plate of the lock is secured, an arm being let into the framing to such an extent that it comes opposite to the bolt of the lock and in line with it in such a position that when the bolt is shot forward, it pushes the arm in the direction indicated by the arrow and lifts a second arm out of contact, thus opening the circuit. 2 claims.

12,291. "Improvements in secondary batteries." A. J. Boult. (A communication from H. Woodward, of Canada.) Dated June 22nd. Consists, essentially, of a single positive or negative electrode surrounded by, but electrically insulated from, a series of electrodes connected together and forming an electrode to work with the central electrode. 2 claims.

12,457. "Improvements in junction boxes for underground electrical conductors." D. Urquhart and J. M. Small. Dated June 24th. Claims:—1. A junction box for underground electrical conductors, consisting of a base of insulating material and a cover having its lower edge immersed in oil in a groove of the base, and in the chamber thus formed detachable links and bars connecting ends of the cables which are passed up through holes of the base, charged with insulating material, substantially as described. 2. In a junction box, such as is above referred to, an air tube through the cover entering a box containing material absorbent of moisture, substantially as and for the purpose set forth. 3. The described method of filling with oil a junction box, such as is above referred to.

12,577. "Improvements in the underground system of electric traction." J. A. K. McGregor. Dated June 27th. Consists of a special form of switch and switch chamber, and in the method of suspension of the sectional conductor in combination with the double trolley adapted to make contact with said sectional conductors, and carry the current to the motor upon the car, and at the same time to operate the switches at the junctions of the sections. 9 claims.

12,806. "Improvements in electric lighting and switches therefor." F. A. Thum. Dated June 30th. Consists in the improved switch, its connection with the source of electricity and with the lights, and also in the arrangement and combination of the various parts. 3 claims.

13,279. "Improvements in ear pieces for telephones." R. Seifert. Dated July 7th. Consists of a disc provided with devices for holding it centrally upon the receiving instrument of a telephone, and having a perforation that is located centrally over the diaphragm when the disc is placed upon such instrument. This disc is small enough to be carried in the pocket, and when it is desired to use the telephone it can be readily placed upon the receiving instrument. 2 claims.

13,408. "Improvements in electric batteries." J. H. Mason and A. Van Derwerken. Dated July 11th. Claim:—In an electric battery, the combination with a cell of a carbon element, having the central post and radial portions, a cup having a porous bottom and supported by the carbon element, and the zinc element supported on the bottom of said cup, substantially as specified.

14,910. "A method of and apparatus for electrolytical decomposition while using quicksilver as cathode." P. Jensen. (A communication from abroad by A. Sinding-Larsen, of Christiania.) Dated August 3rd. Consists in the application of the anode and cathode in the same space, the decomposing cell, wherein the quicksilver forming the cathode is contained with a surface perfectly free towards the electrolyte, the quicksilver having also a surface perfectly free towards another space which is quite independent of the decomposing cell, and contains the reagent necessary for the production of the alkali compound in question; also in putting the mass of quicksilver in circulation between the two active surfaces, viz., the one towards the decomposing liquid and the one towards the dissolving reagent, so that the water of the electrolyte gets no time to react on the alkali metal. 5 claims.